Atlas of

FIBEROPTIC BRONCHOSCOPY

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Rajendra Prasad

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Atlas of Fiberoptic Bronchoscopy

First Edition: **2014**

ISBN: 978-93-5090-340-7

Printed at

Dedicated to

My parents,
wife and children
for their love, patience and encouragement

Preface

Professor Shigeto Ikeda's invention of fiberoptic bronchoscopy has revolutionized the practice of medicine. As 21st century progresses, fiberoptic bronchoscopy has become the most common and important procedure in the practice of pulmonary medicine and I have witnessed tremendous increase in application of fiberoptic bronchoscopy in clinical practice today.

Although fiberoptic bronchoscopy was started in department of pulmonary medicine at King George's Medical College, Lucknow, Uttar Pradesh, India, for the first time in 1986 and we have acquired state-of-the-art video bronchoscopy unit for the first time in the state of Uttar Pradesh in the year 2000, since then the photography, record keeping, teaching and training has become much easier.

This book was written with the aim of defining an approach to the diagnosis of common pulmonary diseases based on abnormal bronchoscopic findings. The text consists of two parts, the first, a practical introduction and the second, X-ray, computed tomography (CT) and bronchoscopic pictures of interesting cases selected from 2,000 bronchoscopic procedures done in the last 15 years.

Undergraduates, postgraduates, medical students, chest physicians, thoracic surgeons, general physicians having special interest in pulmonary diseases and otolaryngologists will find this book as a practical guide.

Rajendra Prasad

Acknowledgments

There are many individuals who have contributed to its successful completion, some have made such important contributions that I take special pleasure in acknowledging my heartfelt indebtedness to them. I am indebted to Dr Rajiv Garg, Dr Kushwaha RAS, Dr Verma SK, Dr Yaswant, Dr Ashish Rout, Dr Gupta GL, Dr Shashank Ojha, Dr Verma RK, Dr Amit Verma, Dr Sanjay Verma, Dr Kiran Vishnu Narayan, Dr Suneesh C Anand, Dr Giridhar BH, Dr Abhijeet Singh, Dr S Saheer, Dr Jabeed P and Dr Nikhil Gupta, for their constant support and encouragement. I am also thankful to Mr Verma VK and Mr Sunni Razzak.

I am grateful to the following for their splendid contribution to the book, Mr Sudhanshu Tewari for design and illustrations, and Mr Ashish Yadav and Mahtab Khan for typing and illustrations. At the last I am thankful to all my patients who have cooperated fully during bronchoscopy and helped me to learn more and more about pulmonary diseases.

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CHAPTER

1 History of Bronchoscopy

Kirstein visualized the interior of a patient's larynx directly with O'Dwyer's tube in 1885. It was in 1897, that Gustav Killian from the University of Freiburg, Germany, known as the 'father of bronchoscopy', who reportedly investigated the lower trachea and main stem bronchi using a Kirstein laryngoscope.[1] Later by the year 1905, Professor Chevalier Jackson,[2] improved on the rigid bronchoscope and established bronchoscopy as a standard diagnostic tool. Professor Inokichi Kubo of Kyushu University, Japan, who studied at Professor Killian Laboratory in 1907, was the first to practice bronchoscopy. Inspite of many improvements, the rigid bronchoscope namely the early Jackson type had a poor level of illumination and limited visual field.

However, with the progress of thoracic surgery, the need for bronchoscopy increased, which led to a technically improved bronchoscope and the development of new fields of diagnosis. The widespread use of the improved Jackson type bronchoscope motivated, further improvement of the bronchoscope. Kozuki and Horie[3] developed and improved the high power illumination system, using a Xenon discharge as a source of light. In addition, they developed the rigid bronchoscope using glass fibers as a light guide. Dr Shigeto Ikeda,[4] introduced the first commercially available flexible fiberoptic bronchoscope in 1967. It has an outer diameter of 4 to 6 mm, is soft and its tip can be moved through an angle of 150° to 180°. The fiberoptic bronchoscope's tip has a wide range of viewing angle ranging from 55° to 120°. So as against the old bronchoscope, which could visualize only the proximal bronchus, the fiberoptic bronchoscope has an extended visualization up to the 4th order subsegmental bronchi. In addition, its visual images are strikingly clear inspite of using glass fibers. It also helps in the collection of specimens by using biopsy forceps or brushes and these specimens can be examined in a variety of ways.

Ikeda has also been the forerunner in the development of video bronchoscopy. He introduced a prototype video bronchoscope in 1987.[5] This system eliminated the optical fiber bundle and replaced it with a charge-coupled device (CCD) image sensor, that transmits the image to a video bronchoscope for display on a television monitor. The advances of the video bronchoscope are its improved resolution and its ability to manipulate a digitalized signal on various recording medias. The video bronchoscope offers the potential to become the next generation instrument for visualizing the tracheobronchial tree. The use of the flexible fiberoptic bronchoscope has spread widely and procedures using this instrument has become a routine among physicians, surgeons and radiologists. Today it is said that, no physician specializing in respiratory medicine is considered adequately trained, unless competent with the bronchoscope.

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CHAPTER

2 Normal Bronchial Anatomy and Nomenclature

An understanding of the normal anatomy and endoscopic appearance of the airways is essential for the practice of bronchoscopy. Common normal variations must also be appreciated, if any pathological change is to be recognized. The bronchoscope can be inserted into the airways via the nasal passages, oral route or through a tracheostomy stoma. Therefore, it is required that the bronchoscopist possess an adequate knowledge of the upper airway anatomy.

UPPER AIRWAY

The upper airway comprises of the nose, pharynx and larynx. Careful examination of these areas is essential for the investigation of hemoptysis, persistent hoarseness and unexplained cough. The majority of bronchoscopic examinations are performed through the nose, but in patients with smaller nasal passages oral route may have to be preferred.

Nasal Passages

In normal adults, the nasal airways narrow behind the nostril at the mucocutaneous junction, before leading into the inner main nasal passage. The roof of nasal cavity is formed by the cribriform plate and the palate forms the floor. From the lateral wall projects the folded nasal turbinates. The medial wall of the nasal cavity is formed by the flat nasal septum.

Pharynx

Posteriorly, the nasal passages open into the nasopharynx through the choanae and at this point, the airway makes an almost 90º turn caudally into the posterior nasopharyngeal wall. The inferior border of the nasal septum ends and arches to the top of the nasopharynx. The eustachian tubes enter the lateral wall of the nasopharynx at this site and lying behind the orifices, on the posterior wall are the adenoids. An important landmark in the oropharynx is the base of the tongue. At this location the mucosal surface of tongue meets and joins the anterior surface of the epiglottis and forms the vallecula (Fig. 2.1). Opposite and superior to this location is the uvula in the midline. Lateral to the lateral glossoepiglottic folds are the pyriform sinuses of the pharynx. While inserting the bronchoscope, it is possible to enter these blind pouches and become disoriented. The orophaynx leads directly to the larynx.

Larynx

The larynx begins at the opening bounded anteriorly by the free border of the epiglottis, laterally by the aryepiglottic folds, posteriorly by the corniculate tubercles of the

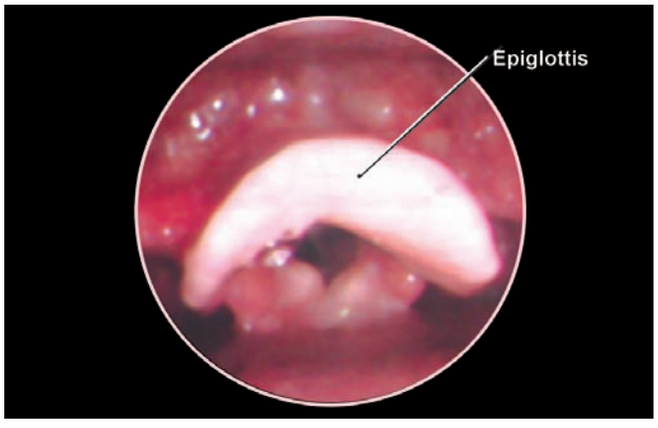

Fig. 2.1: Epiglottis

arytenoid cartilages (Fig. 2.2). Just beyond these structures, the ventricular folds may be seen (false vocal cords), which are tissue folds lateral, parallel and superior to true vocal cords. True vocal cords lie, immediately below the false vocal cords and are formed by tough fibroelastic bands extending forward from the anterior surface of arytenoid cartilages, to the midline of thyroid cartilages. The true vocal cords form an opening into the trachea, which is the glottis (Fig. 2.3). Further downwards, the cricoid cartilage is suspended from the inferior aspect of thyroid cartilage. This forms a complete ring at the inferior aspect of the larynx and is fixed to the tracheal rings.

LOWER AIRWAY

The lower airway comprises the trachea, bronchi and bronchioles (Fig. 2.4).

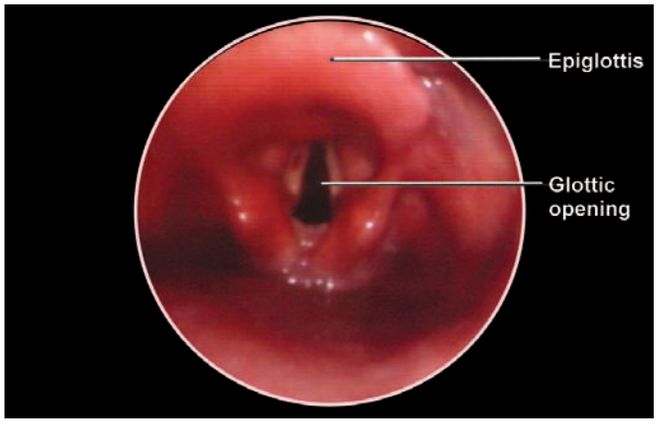

Fig. 2.2: Larynx

Fig. 2.3: Vocal cords and glottis

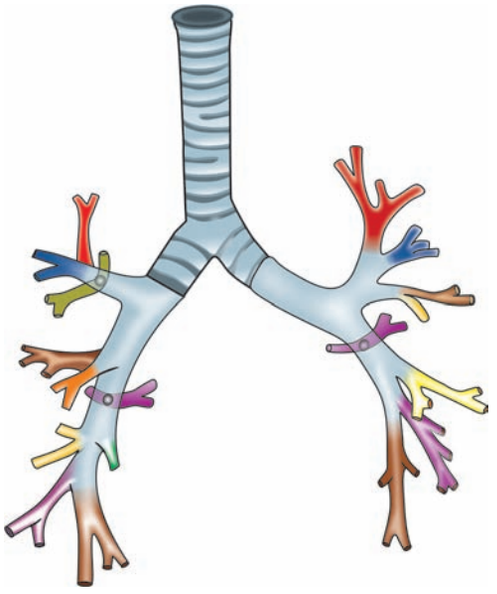

Fig. 2.4: Tracheobronchial tree

Trachea

The trachea is attached above to the cricoid cartilage by the cricotracheal membrane at the level of the sixth cervical vertebra (Fig. 2.5). It extends through the neck into the upper mediastinum and bifurcates into the right and left main bronchi, at the level of sternal angle in front and the fourth thoracic vertebra behind. In adults the trachea is approximately 12 to 14 cm in length. The trachea divides into the right and left main stem bronchi at the carina. The tracheal wall consists of a larger ventrolateral part containing cartilage rings and a flat dorsal muscular wall. There are 16 to 20 'C'-shaped cartilage rings, which are deficient posteriorly. The mucosa and submucosa of the tracheal wall varies in thickness, being thinnest over the cartilages and thickest over the dorsal muscular wall, where longitudinal folds may appear as the muscle is contracted. Just above the tracheal bifurcation, pulsations can usually be seen, where the aortic arch crosses the trachea transversely on its left wall. During inspiration, the trachea dilates to develop an almost circular lumen and during expiration, the posterior membranous wall encroaches into the lumen to produce a kidney-shaped cross-section.

Main Carina

The carina is a keel-shaped spur at the distal end of trachea and oriented in an anteroposterior plane. It is normally sharp and it is anteroposterior dimensions increase during inspiration and decrease during expiration. A widened carina may indicate subcarinal lymphadenopathy (Fig. 2.6).

Bronchi

The left and right main bronchus and bronchus intermedius have cartilage rings, usually 9 to 12 in the left main bronchus, 6 to 8 in the right main bronchus and 4 to 6 in the bronchus intermedius (Fig. 2.7). In adults, the course of right main bronchus is more direct than that of the left main bronchus (Fig. 2.8).

Right Upper Lobe Bronchus

The bronchus to the right upper lobe arises from the lateral aspect of the main bronchus approximately 2 cm from the main carina. It divides about 1 cm from its origin into three segmental branches—anterior, posterior and apical (Figs 2.9 to 2.13).

Right Middle Lobe Bronchus

The bronchus intermedius after 3 to 4 cm from its origin, bifurcates into middle and lower lobe bronchi. The middle lobe bronchus arises almost opposite to the superior segmental bronchus of the lower lobe and divides 1 to 2 cm from its origin into two segmental bronchi, lateral and medial (Figs 2.14 to 2.17).

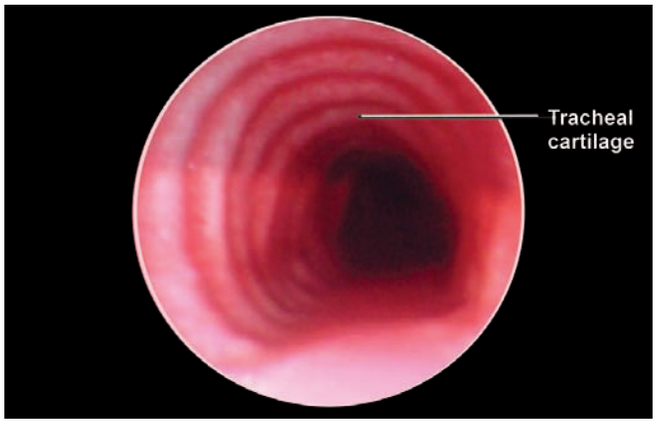

Fig. 2.5: Tracheal cartilage

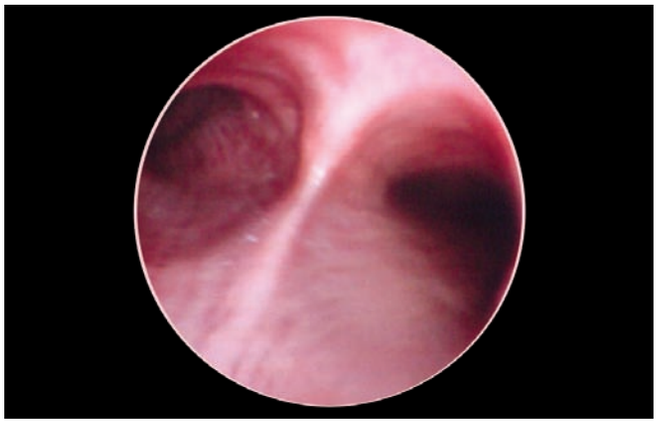

Fig. 2.6: Main carina

Fig. 2.7: Right and left main bronchus

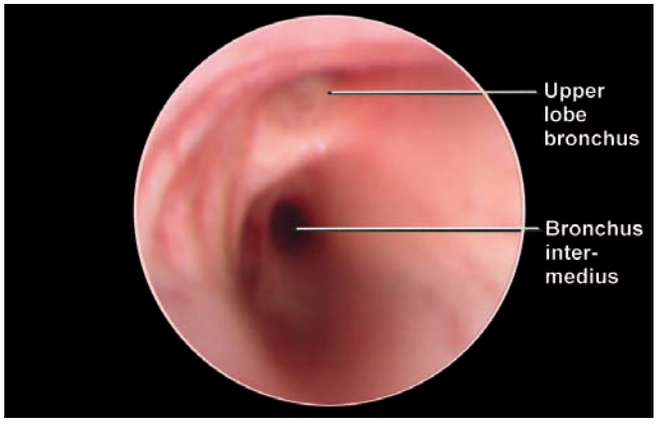

Fig. 2.8: Right main bronchus

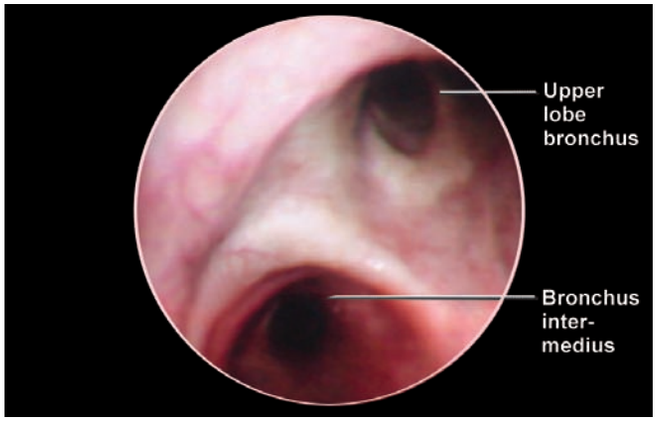

Fig. 2.9: Right upper lobe bronchus (RUL) and bronchus intermedius (BI)

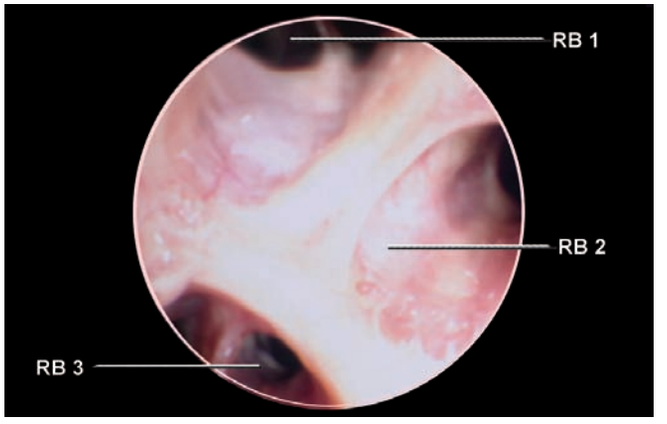

Fig. 2.10: Right upper lobe bronchus

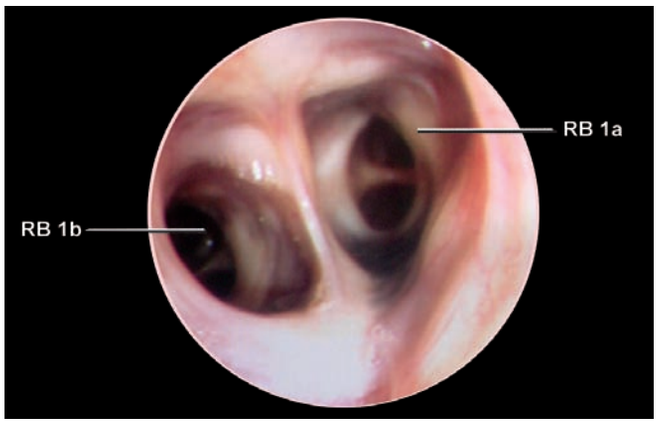

Fig. 2.11: Apical segment of right upper lobe

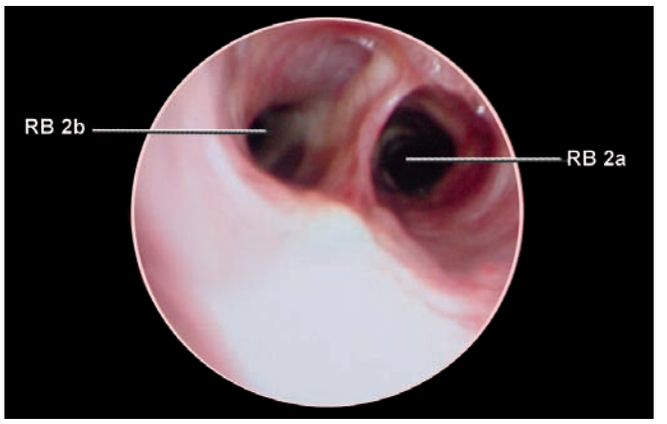

Fig. 2.12: Posterior segment of right upper lobe

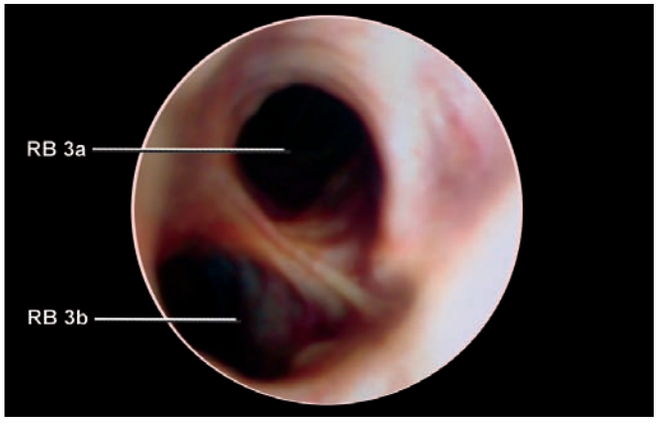

Fig. 2.13: Anterior segment of right upper lobe

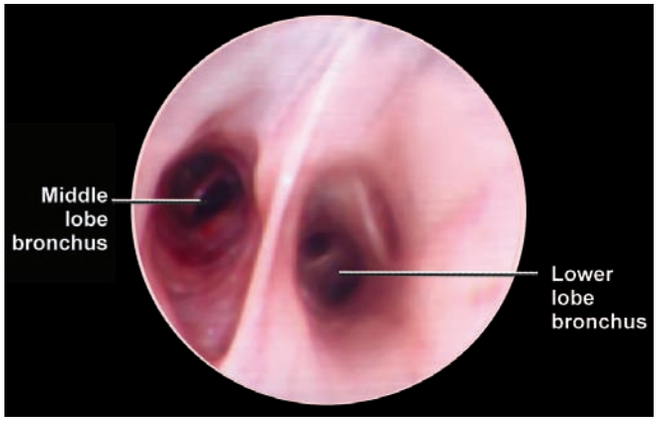

Fig. 2.14: Right middle and lower lobe bronchus

Right Lower Lobe Bronchus

Right lower lobe bronchus divides into five segmental bronchi. The superior segmental bronchus arises from its posterior aspect, just beyond the origin of right lower lobe bronchus. A little lower, the medial basal bronchus arises medially followed by further divisions of lower bronchus into the anterior, lateral and posterior basal bronchi (Figs 2.18 to 2.25).

Left Upper Lobe Bronchus

The left upper lobe bronchial division arises about 5 cm from the carina. The bronchus to the left upper lobe after about 1 cm from its origin bifurcates or trifurcates. In bifurcation the upper division divides into apicoposterior and anterior segments, while the lower division is the lingular bronchus. In the trifurcation apicoposterior, anterior and lingular bronchi originates simultaneously. The lingular bronchus then divides into superior and inferior divisions (Figs 2.26 to 2.31).

Left Lower Lobe Bronchus

The divisions of the left lower lobe bronchus are almost identical to the right lower lobe, except for the absence of a separate medial basal bronchus (Figs 2.32 to 2.37).

NOMENCLATURE OF THE TRACHEOBRONCHIAL TREE

It is important to become familiar with the classification of the tracheobronchial tree. The use of appropriate terminologies to describe the bronchi in the recording of bronchoscopic findings will help in clear communication

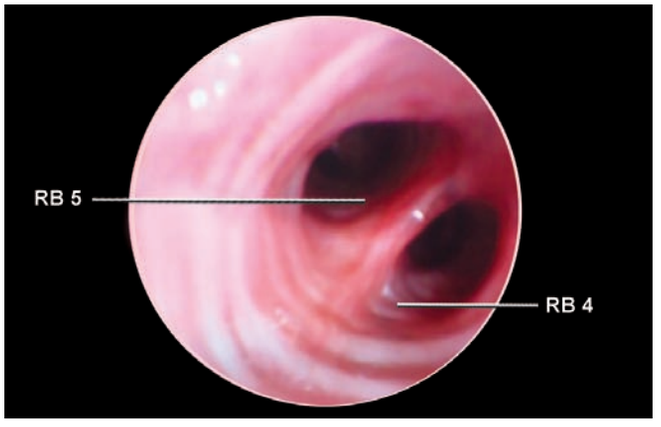

Fig. 2.15: Right middle lobe bronchus

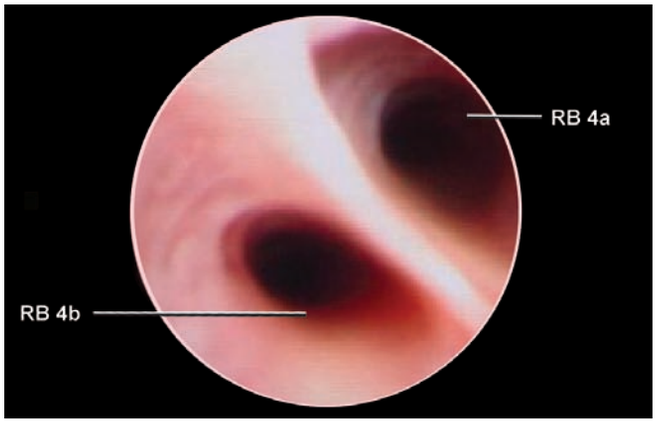

Fig. 2.16: Lateral segment of right middle lobe

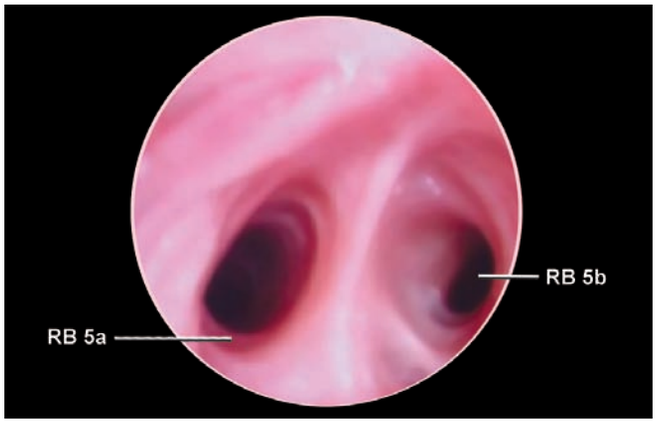

Fig. 2.17: Medial segment of right middle lobe

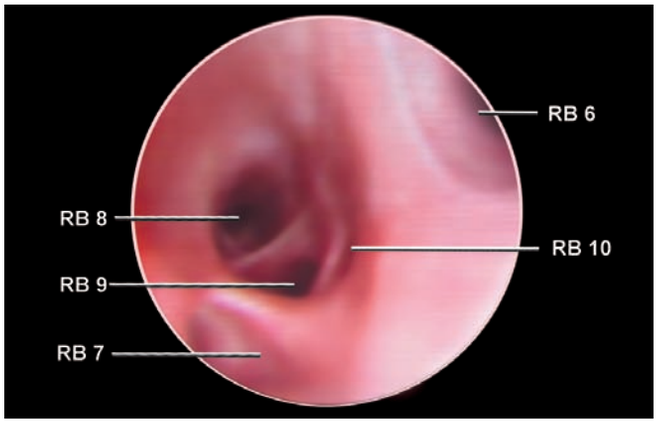

Fig. 2.18: Right lower lobe bronchus

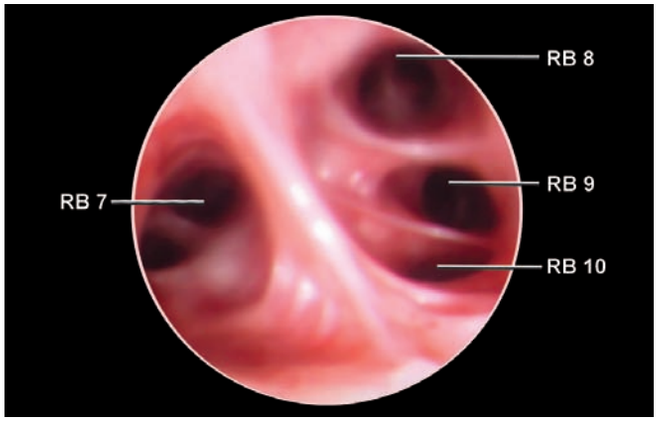

Fig. 2.19: Basal segments of right lower lobe bronchus

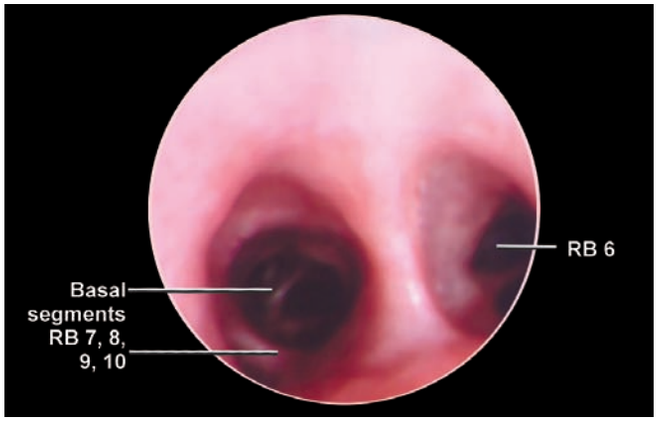

Fig. 2.20: Right lower lobe bronchus

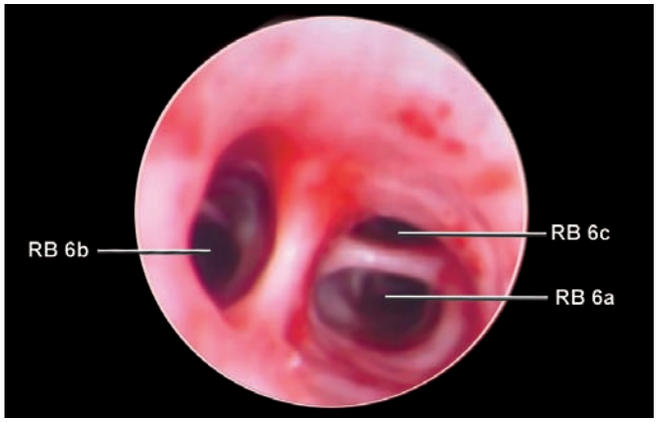

Fig. 2.21: Superior segment of right lower lobe bronchus

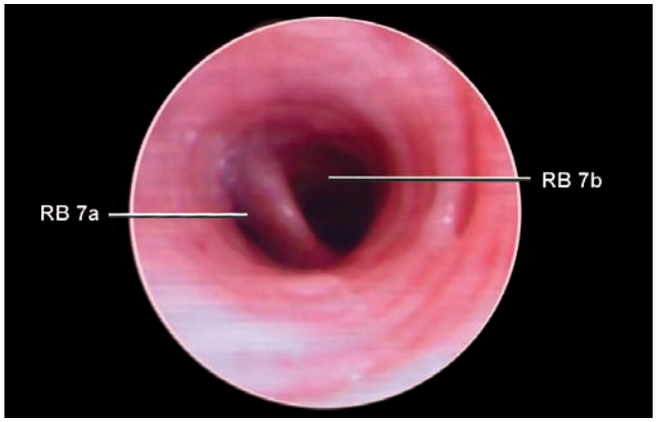

Fig. 2.22: Medial basal segment of right lower lobe bronchus

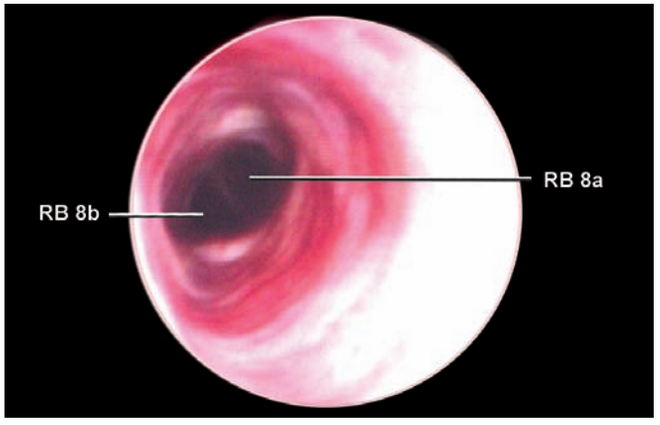

Fig. 2.23: Anterior basal segment of right lower lobe bronchus

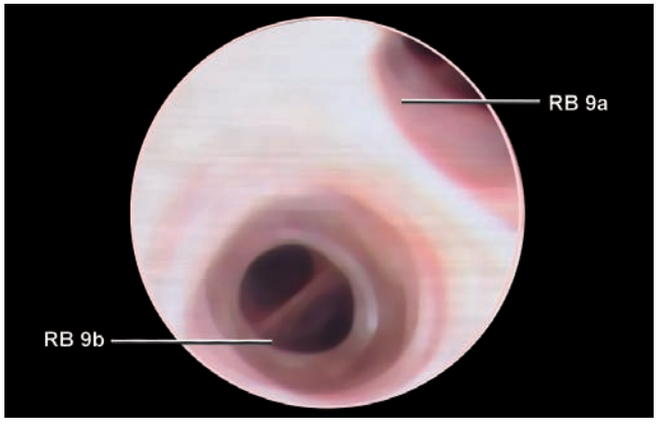

Fig. 2.24: Lateral basal segment of right lower lobe bronchus

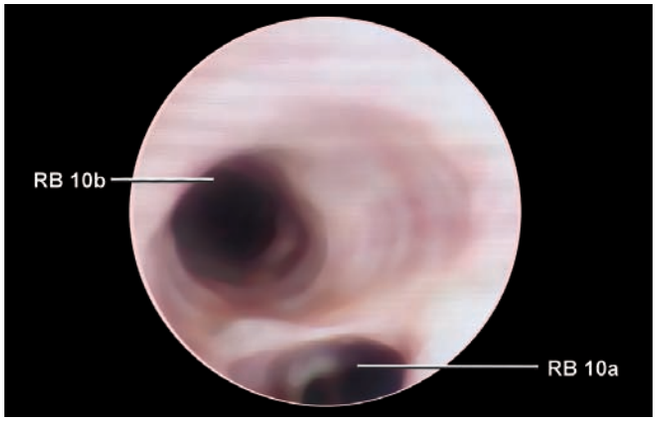

Fig. 2.25: Posterior basal segment of right lower lobe bronchus

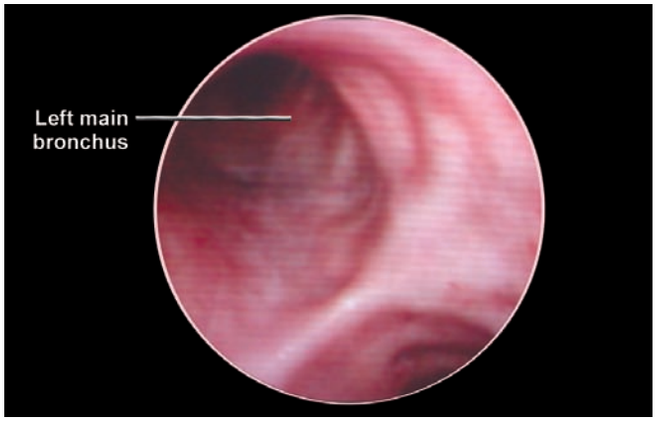

Fig. 2.26: Left main bronchus

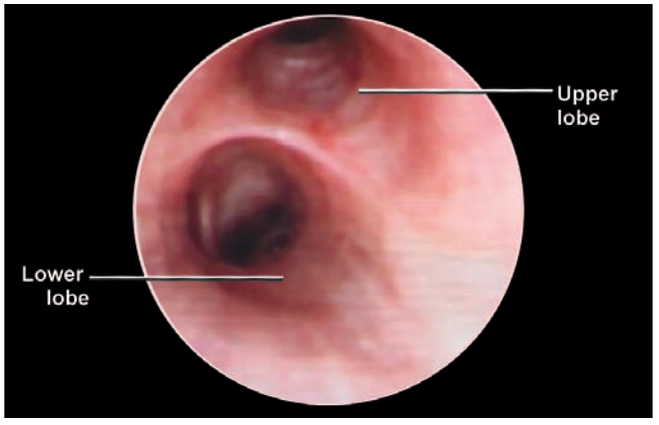

Fig. 2.27: Left main bronchus dividing into two lobes

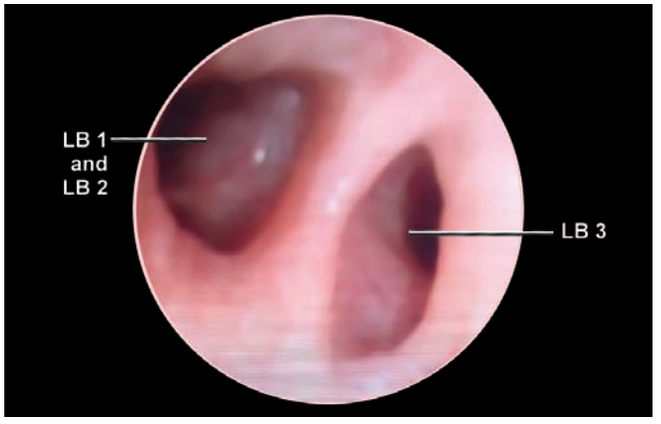

Fig. 2.28: Upper division left upper lobe

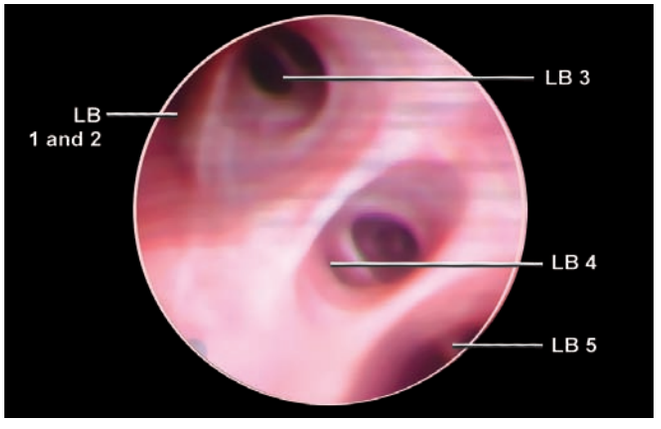

Fig. 2.29: Left upper lobe bronchus

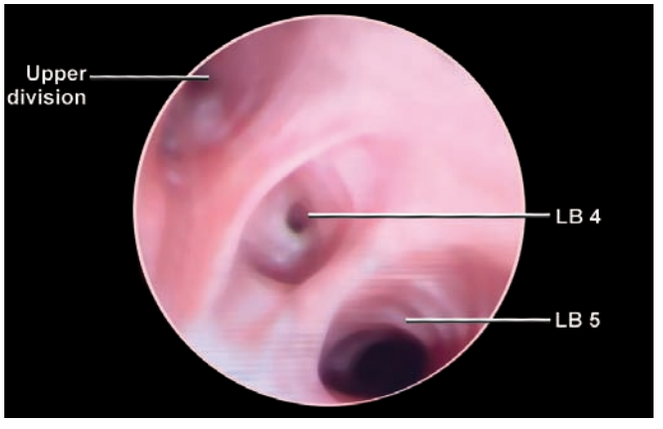

Fig. 2.30: Left upper lobe bronchus

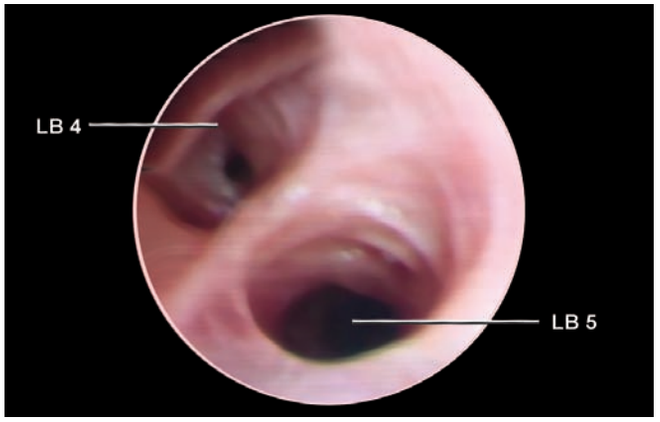

Fig. 2.31: Lower division of left upper lobe bronchus

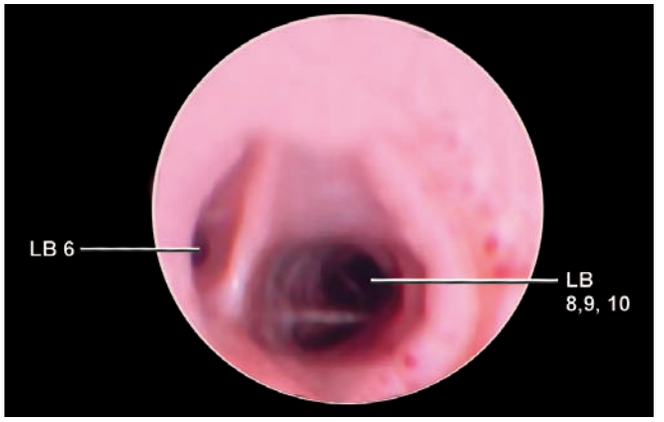

Fig. 2.32: Left lower lobe

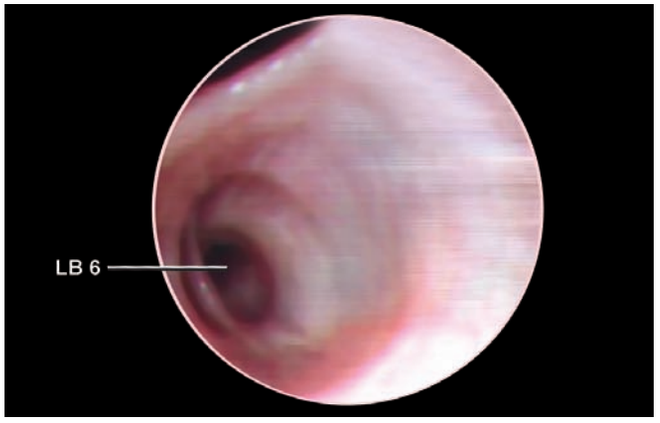

Fig. 2.33: Superior segment of left lower lobe

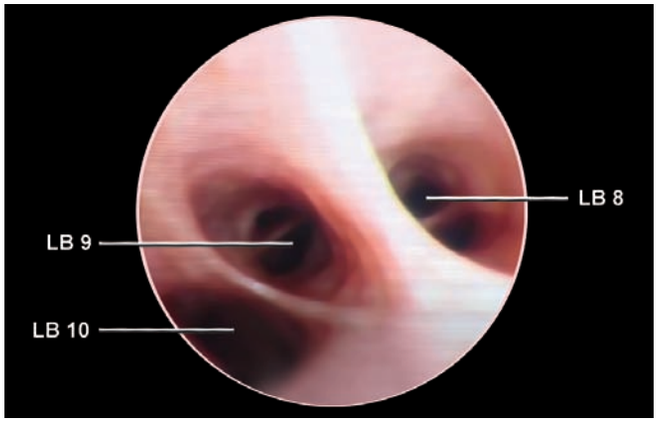

Fig. 2.34: Basal segments of left lower lobe

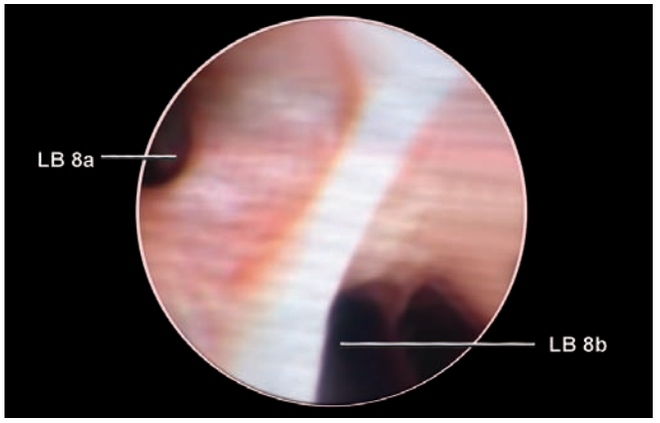

Fig. 2.35: Anterior basal segments of left lower lobe

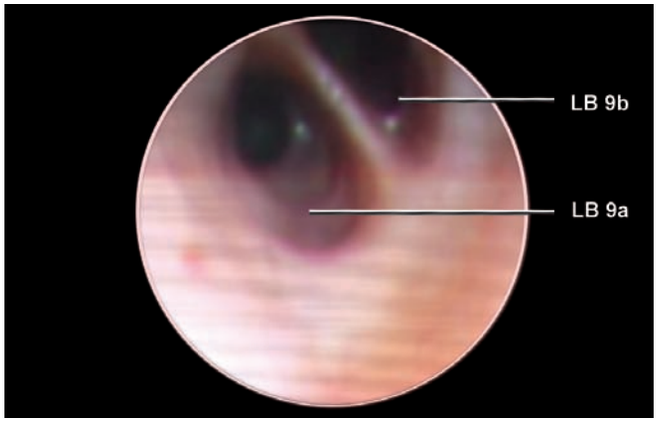

Fig. 2.36: Lateral basal segments of left lower lobe

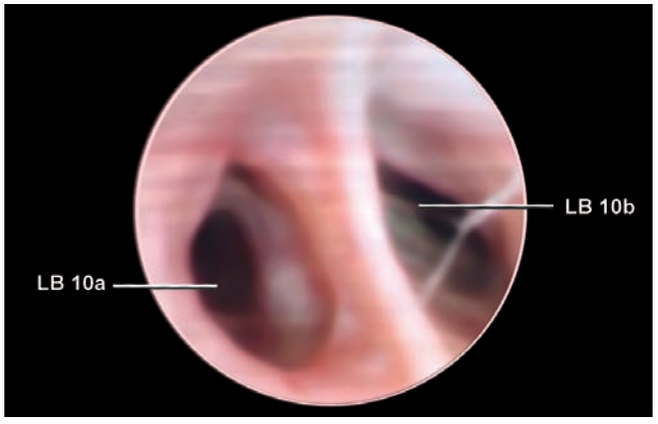

Fig. 2.37: Posterior basal segments of left lower lobe

among bronchoscopists. Although, there are some variations in the bronchial nomenclature between the British and the commonly used system, the present system of commonly used bronchial nomenclature (Table 2.1) is based on the pioneer studies by Jackson and Huber,[1] Boyden and associates (Table 2.2).[2] More detailed classification of segmental bronchi have been described by Ikeda.[3]

ENDOSCOPIC VISUALIZATION

The bronchoscopic appearance of the mucous membrane is naturally influenced by age, sex and environmental factors. Endoscopically the normal bronchial mucosa appears as a glossy pink membrane. Small vessels may be seen around the carina and in the walls of the main bronchi. These are the branches of the bronchial circulation. These vessels are most prominent in the cartilaginous grooves and thin out over the cartilages themselves. Normal mucosa and submucosa form a thin membrane closely following all contours of the tracheal and bronchial walls, thus clearly revealing the presence or absence of supporting cartilage, mucus duct orifices or any small changes in the walls. The normal mucosa blushes readily and rapidly on slight trauma. A very thin layer of mucus gives the characteristic shine of the bronchial mucosa. Small collections of mucus are commonly encountered in normal airways, but if repeated aspiration is required to keep the field of vision clear, then excess secretion are present. With increasing age, a gradual atrophy of the submucosa occurs with the mucosa appearing paler, the cartilages and carina becoming thinner and sharper. In chronic smokers or people, who have worked for many years in a dusty or smoke-filled environment, the bronchial mucous membrane may show deposits of inhaled substance thus appearing blackish.

CATEGORIZATION OF BRONCHOSCOPIC FINDINGS

The carina is keel-shaped and oriented in an anteroposterior plane. It is normally sharp and its anteroposterior diameter dimensions increase during inspiration and decrease

Table 2.1: Commonly used bronchial nomenclature

Anatomical nomenclature	Numbering system
Right lung (right main bronchus)	
Right upper lobe	
Apical	B^1
Anterior	B^2
Posterior	B^3
Right middle lobe	
Lateral	B^4
Medial	B^5
Right lower lobe	
Superior	B^6
Medial basal	B^7
Anterior basal	B^8
Lateral basal	B^9
Posterior basal	B^{10}
Left lung (left main bronchus)	
Left upper lobe	
Upper division	
Apicoposterior	B^{1+3}
Anterior	B^2
Lingular division	
Superior	B^4
Inferior	B^5
Left lower lobe	
Superior	B^6
Anteromedial	B^{7+8}
Lateral basal	B^9
Posterior basal	B^{10}

Table 2.2: Bronchial nomenclature of Jackson and Huber

Right lung			Left lung			
	B^1 : R apicalis	Rm. apicalis proprius			B^{1-2} : R Apico-dorsalis	Rm apicalis
		Rm (subapicalis) ventralis				Rm (subapicalis) dorsalis
						Rm (lobi sup.) horizontalis
Upper lobe	B^2 : R (lobi superioris) dorsalis	Rm (subapicalis) dorsalis Rm (lobi sup.) horizontalis		Upper division bronchus		
	B^3 : R (lobi superioris) ventralis	Rm (lobi sup. ventr.) lateralis			B^3 : R (lob superioris) ventralis	Rm (lobi sup. ventr.) lateralis
		Rm (lobi sup. ventr.) medialis				Rm (lobi sup. ventr.) medialis
						Rm (lobi sup. ventr.) superior
	B^4 : R medius lateralis	Rm medialis	Upper lobe		B^4 : R lingualis superior	Rm lateralis ventralis
		Rm lateralis				Rm (lobi sup.) ventralis
Middle lobe	B^5 : R medius medialis	Rm medialis		Lower division bronchus	B^5 : R lingualis inferior	Rm superior
		Rm lateralis				Rm inferior
	B^6 : R (lobi inferioris) superior	Rm superior Rm lateralis			B^6 : R (lobi inferioris) superior	Rm superior Rm lateralis
		Rm medialis				Rm medialis
	B : R (lobi inferioris) subsuperior				B : R (lobi inferioris) subsuperior	
	B^7 :R mediobasalis	Rm dorsalis	Lower lobe		Superior	
		Rm ventralis				
Lower lobe	B^8 : R ventrobasalis	Rm lateralis Rm basalis			B^8 : R ventrobasalis	Rm lateralis Rm basalis
		Rm lateralis				Rm lateralis
	B^9 : R laterobasalis	Rm basalis			B^9 : R laterobasalis	Rm basalis
	B^{10} : R dorsobasalis	Rm dorsalis			B^{10} : R dorsobasalis	Rm dorsalis
		Rm lateralis				Rm lateralis
		Rm medialis				Rm medialis

during expiration. Widened carina may indicate subcarinal lymphadenopathy. It is very important to make precise and appropriate descriptions of bronchoscopic findings. Special emphasis should be given to the color, shape, motility and location of the lesion.

Adequate and appropriate documentation of the characteristics of the lesion not only helps in easy understanding of the pathology by another person who might not have participated in the procedure, but also provides information for future reference and comparison. Below is the description adopted by the Japan Lung Society in 1979 (Figs 2.38 to 2.73):

1. The bronchial wall
   a. Redness or pallor

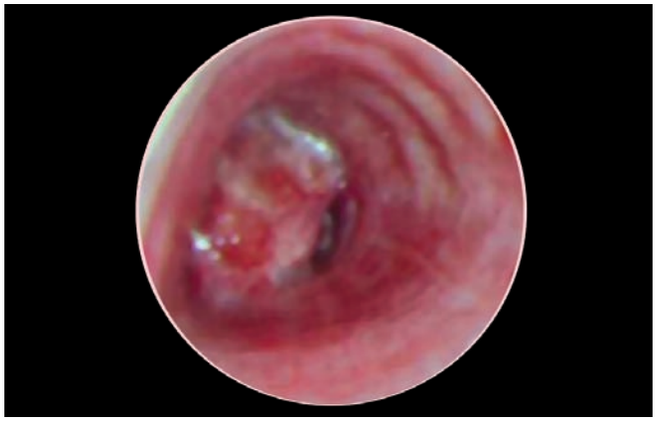

Fig. 2.38: Growth in left main bronchus

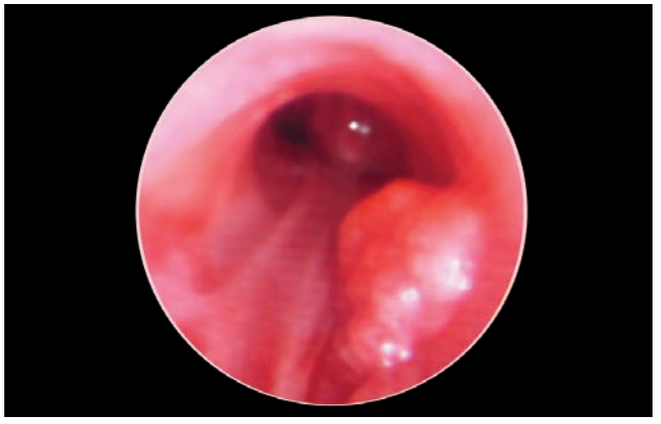

Fig. 2.39: Growth at medial wall of left main bronchus

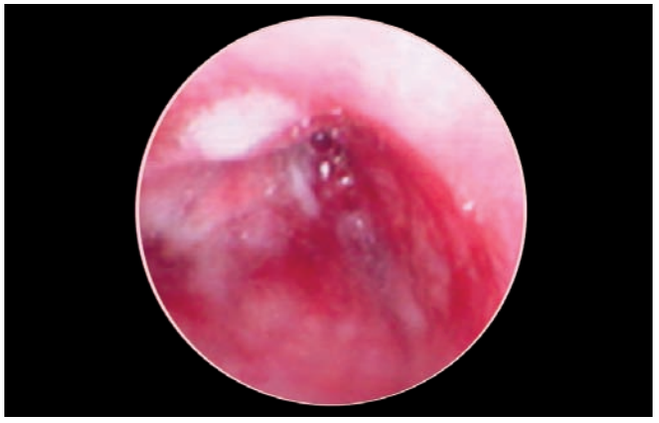

Fig. 2.40: Irregular growth with necrotic slough obstructing left main bronchus

Fig. 2.41: Growth obstructing anterior segment of left upper lobe with involvement of adjacent carina

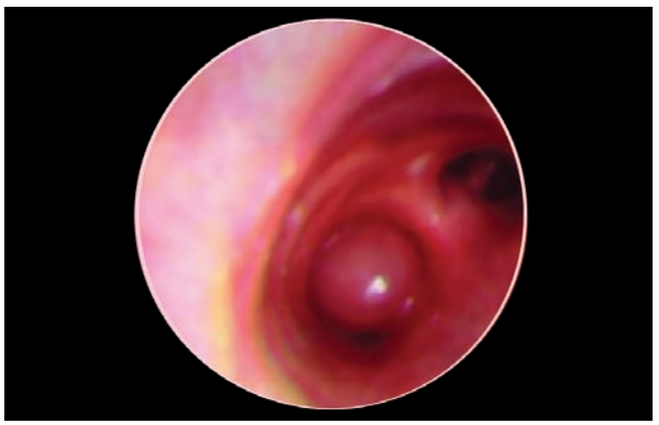

Fig. 2.42: Polyp in bronchus intermedius just after the opening of right upper lobe bronchus

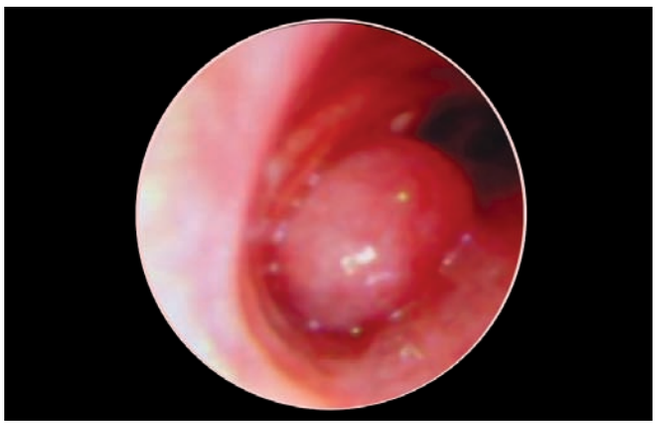

Fig. 2.43: Polyp in bronchus intermedius (close view)

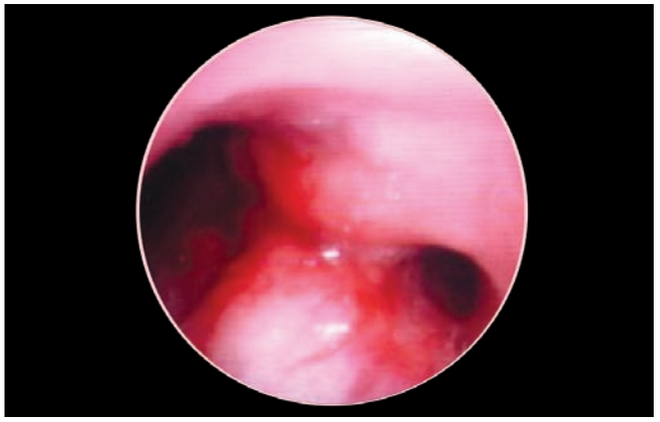

Fig. 2.44: Wide and edematous main carina

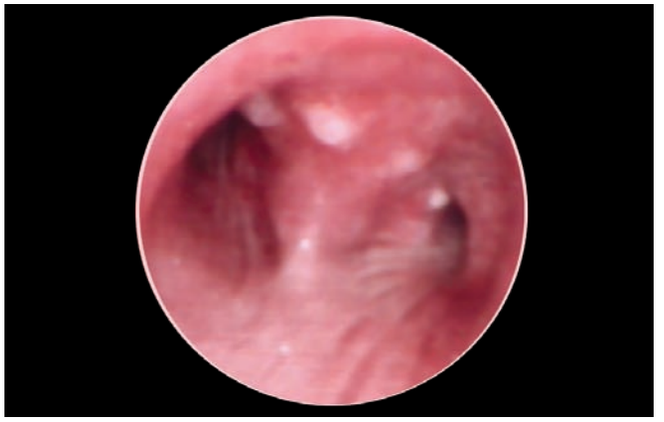

Fig. 2.45: Multiple nodule at main carina

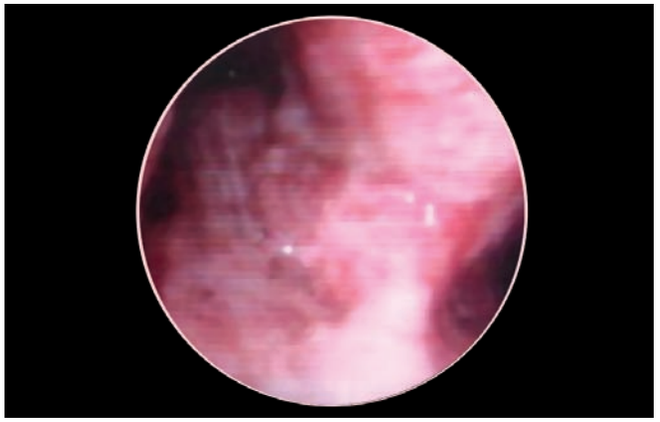

Fig. 2.46: Wide and infiltrated main carina by tumor

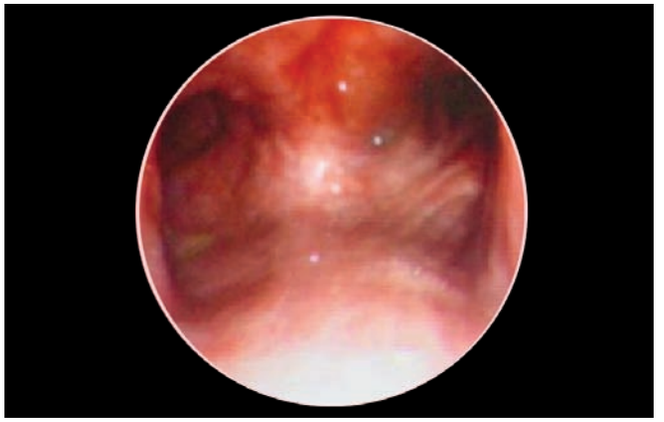

Fig. 2.47: Widening of carina with bulging of lower end of trachea and medial walls of both main bronchus from compression from outside growth

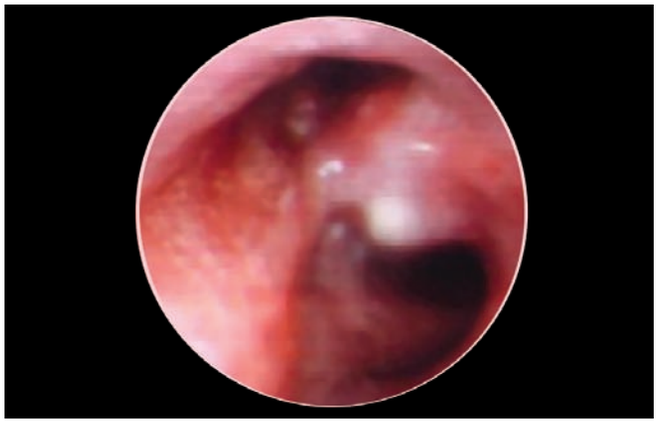

Fig. 2.48: Multinodular growth at main carina

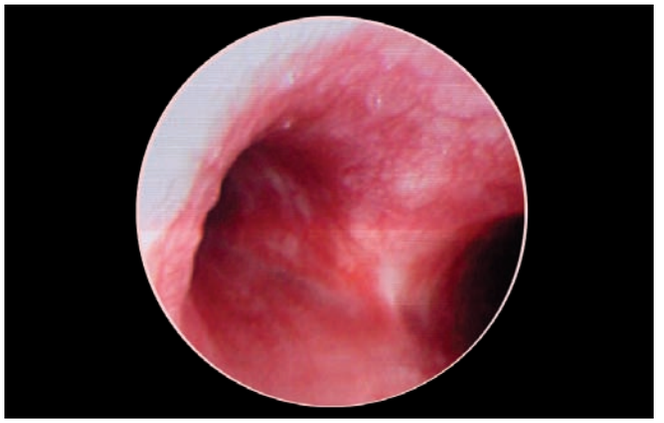

Fig. 2.49: Wide carina

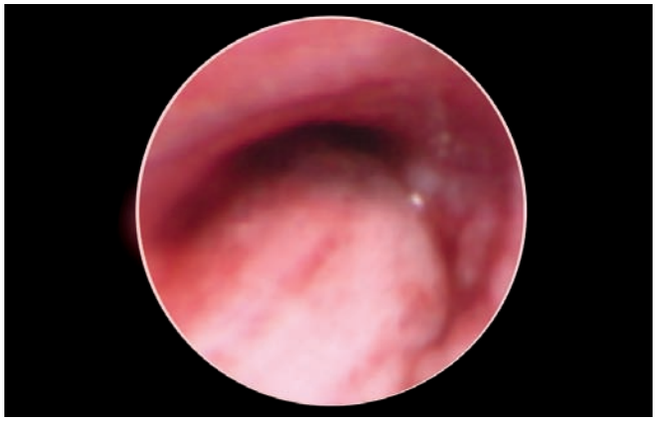

Fig. 2.50: Bulging of lower end of trachea reducing its lumen due to outside compression

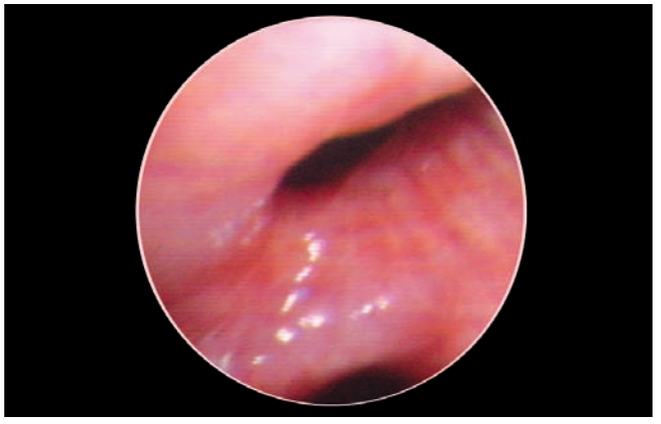

Fig. 2.51: Thick and edematous secondary carina near right upper lobe bronchus

Fig. 2.52: Middle lobe and lower lobe bronchus narrowed with thick secondary carina due to compression from outside

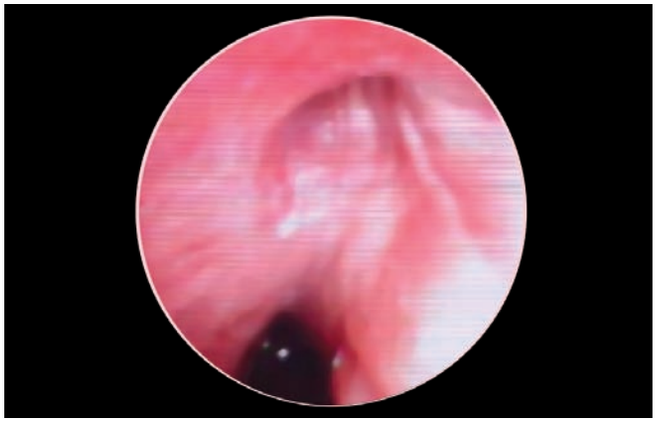

Fig. 2.53: Malignant infiltration of right upper lobe and near by secondary carina

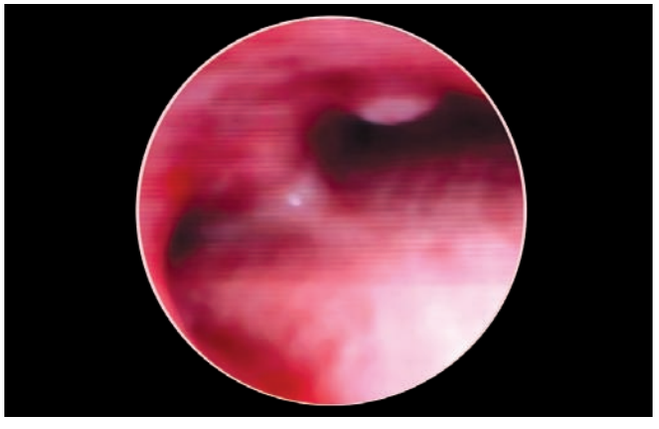

Fig. 2.54: Bleeding from left bronchial tree with whitish nodule on right main bronchus and bulge at the lower end of trachea due to compression from outside

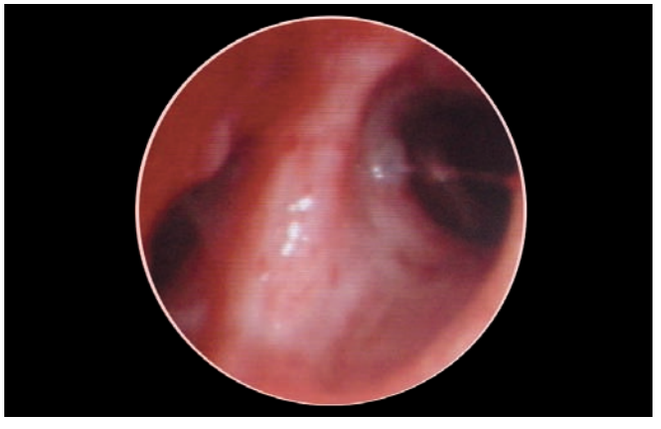

Fig. 2.55: Wide and hyperemic tertiary carina left upper lobe due to compression from outside

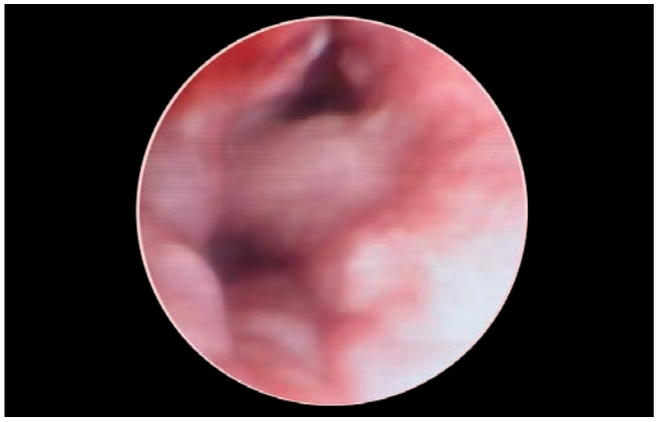

Fig. 2.56: Extensive malignant infiltration of left main bronchus

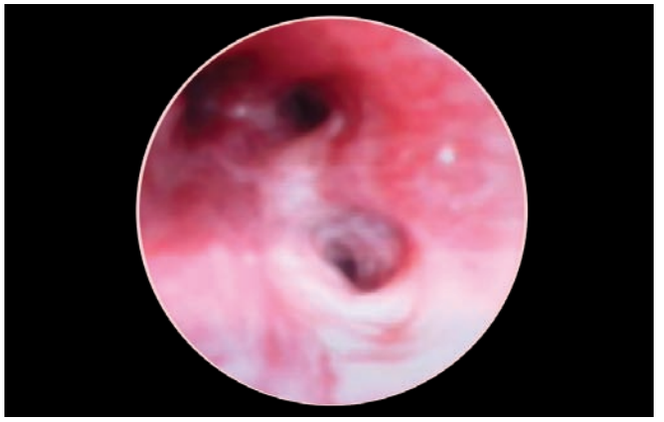

Fig. 2.57: Infiltration of segmental bronchi left upper lobe

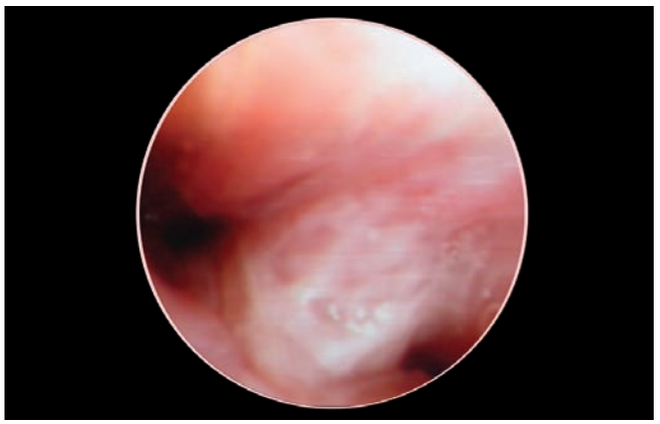

Fig. 2.58: Thick and infiltrated tertiary carina

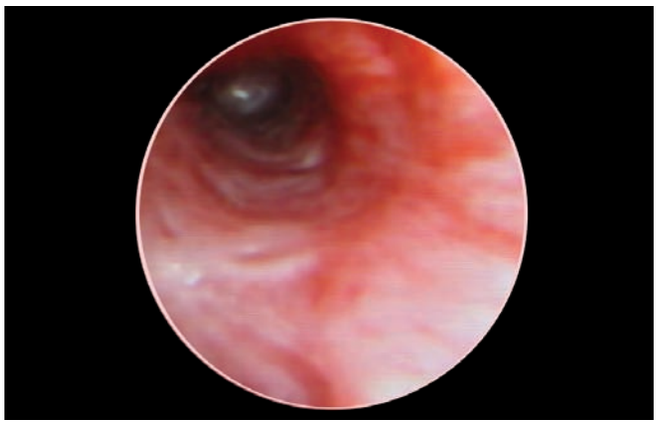

Fig. 2.59: Wide secondary carina between left upper and lower lobe bronchus

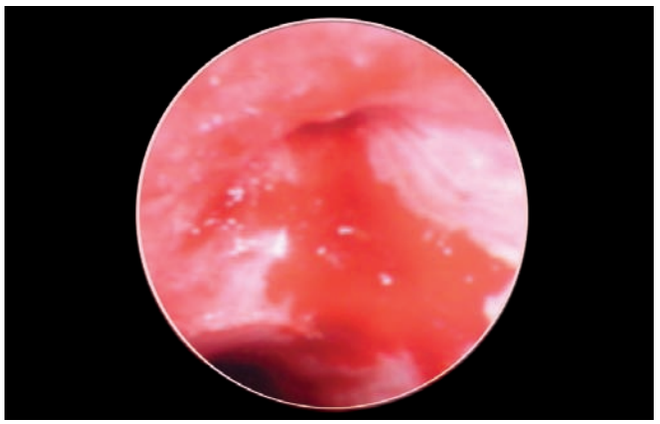

Fig. 2.60: Secondary carina near right upper lobe is wide and infiltrated by tumor reducing lumen of the right upper lobe bronchus with blood coming out

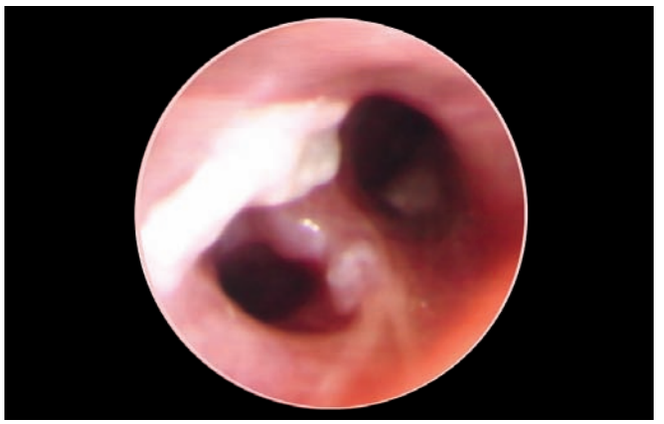

Fig. 2.61: Pus with thick secondary carina

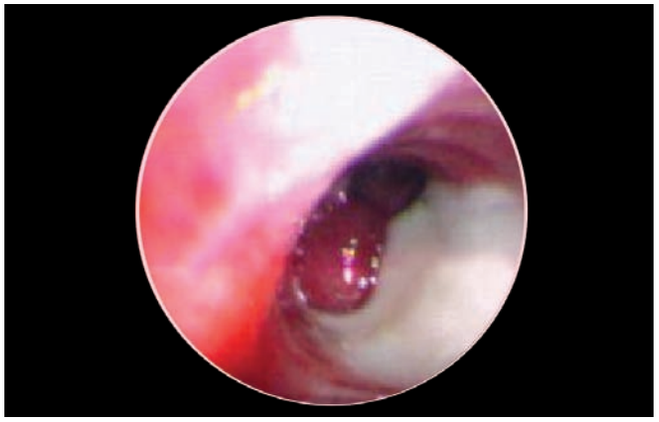

Fig. 2.62: Polyp in bronchus intermedius surrounded by pus

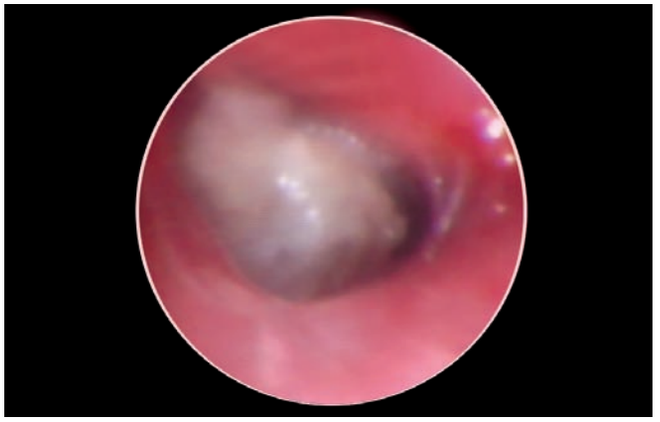

Fig. 2.63: Tumor covered with necrotic slough in anterior segment of right upper lobe

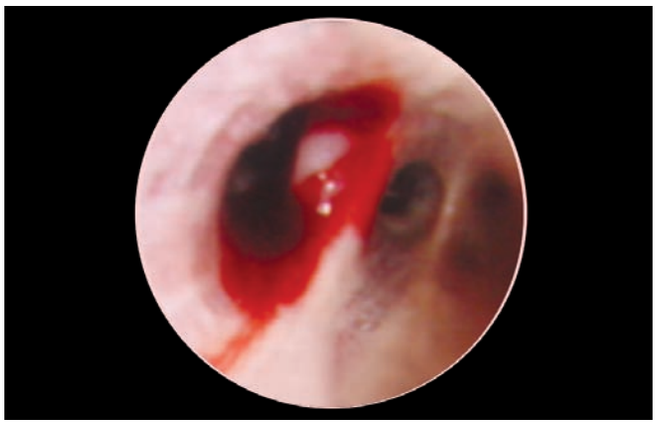

Fig. 2.64: Endobronchial isolated secondary in anterior basal segment of the left lower lobe from squamous cell carcinoma

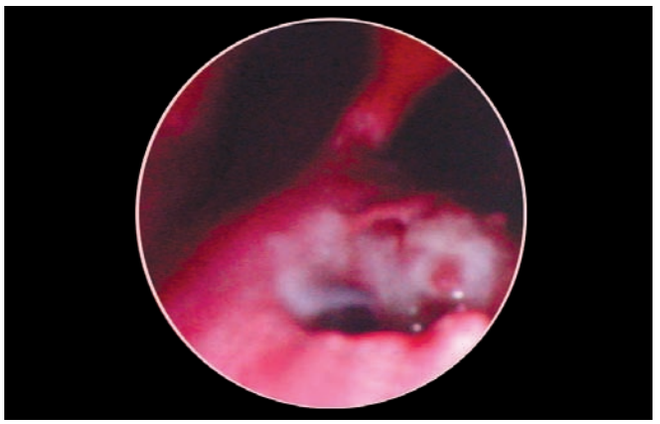

Fig. 2.65: Tuberculous lymphotracheal fistula

Fig. 2.66: Tracheoesophageal fistula from carcinoma esophagus

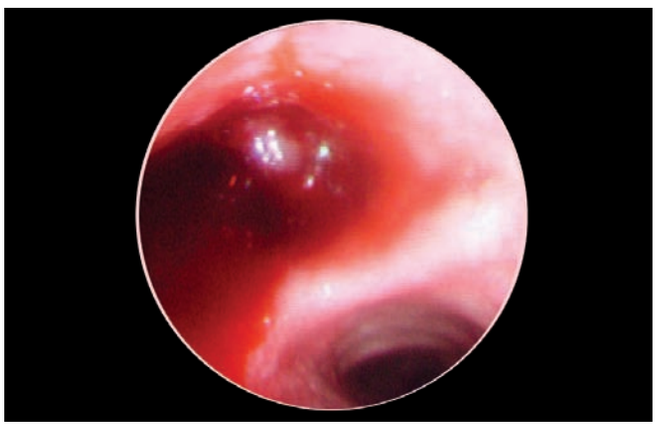

Fig. 2.67: Blood in left main bronchus

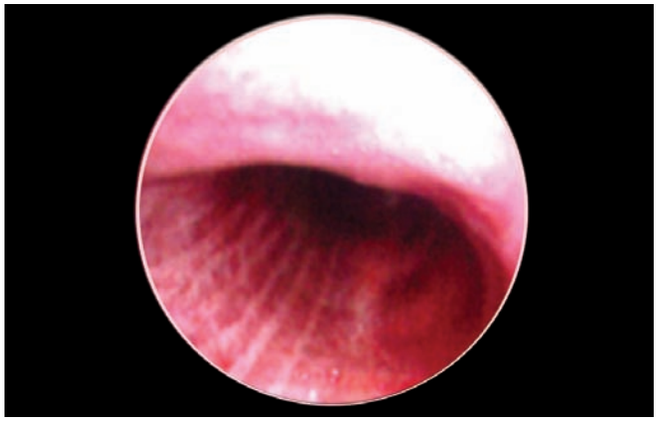

Fig. 2.68: Prominent longitudinal corrugations in chronic bronchitis

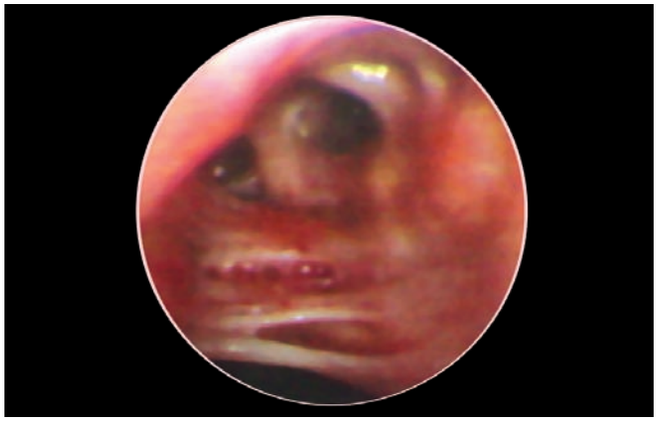

Fig. 2.69: Mucosal pits in chronic bronchitis

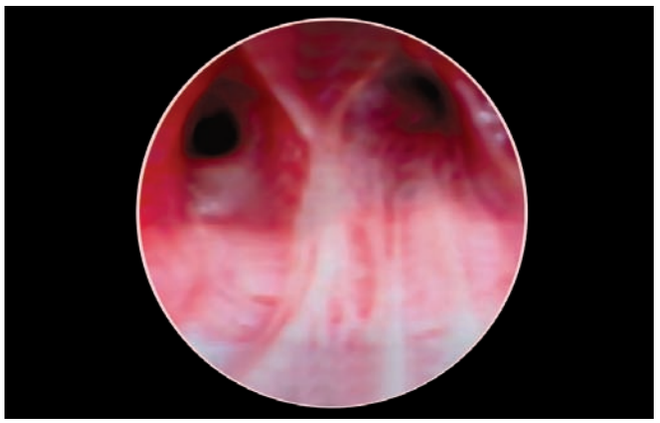

Fig. 2.70: Mucosal thickening in chronic bronchitis

Fig. 2.71: Spider web appearance of vessels in trachea in sarcoidosis

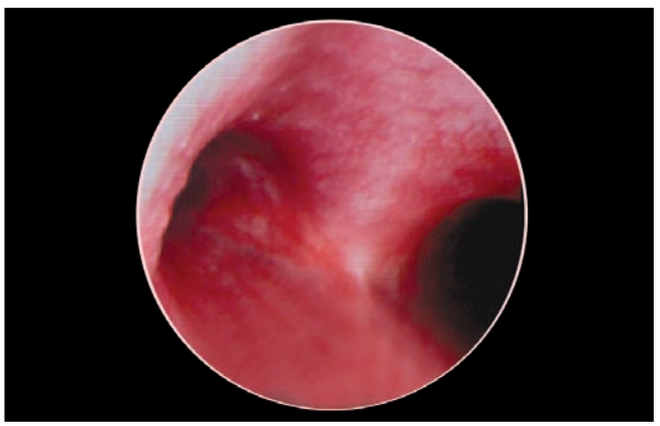

Fig. 2.72: Spider web appearance at carina in sarcoidosis

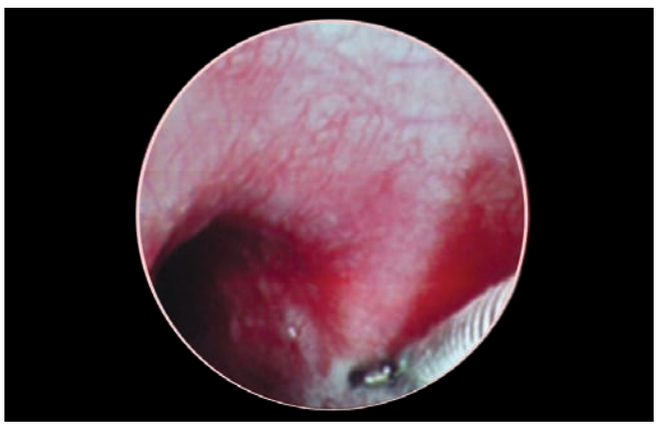

Fig. 2.73: Spider web appearance at carina in sarcoidosis (close view)

b. Absence of mucosal surface luster
c. Swelling (edema)
d. Vascular engorgement
e. Irregular mucosal surface
f. Indistinct cartilage ring
g. Protrusion of bronchial cartilage
h. Ulceration of the bronchial wall
i. Enlargement of the mucous glands
j. Transparent lymph nodes
k. Mucosal atrophy
l. Mucosal thickening
m. Tumor
n. Necrosis
o. Abnormalities in the mucosal folds (irregularities, thickening, indistinctness, disappearance).

2. The bronchial lumen
   a. Stenosis
   b. Obstruction
   c. Enlargement
   d. Compression
   e. Abnormal branching including diverticulum
   f. Abnormal finding at bifurcation (widening, compression, constriction).
3. Pathological substances
   a. Abnormal secretions
   b. Bleeding
   c. Stones
   d. Foreign bodies.
4. Disturbance of movement
   a. Abnormal movement during respiration
   b. Abnormal movement on coughing.

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CHAPTER

3 Abnormal Patterns of Bronchial Anatomy

Abnormal patterns of bronchial anatomy is usually found at bronchoscopy and no great clinical significance can be attached to these, in addition they add as a source of confusion to the amateur bronchoscopist. Variability can be found at the lobar, segmental and subsegmental level. More variability is found at segmental level than in the larger proximal bronchi and right side variations are commoner than that on the left.[1]

ANOMALIES OF BRONCHUS

Variations on the Right Side

Most common major anomaly is a supernumerary right upper lobe bronchus, arising anywhere from the trachea or right main bronchus (Fig. 3.1). Tracheal origin is usually from the right lateral wall 2 cm above carina, where it is named as a 'tracheal bronchus', 'pig bronchus' or ' bronchus suis'.[2,3] The reported prevalence ranges from 0.1 percent in studies of adults to 2 percent in children.[4,5] Six different types of variation of branching in the right upper lobe bronchus can occur.[6] They are:

Type I (the most common) occurs in 40 percent cases, where all three segmental bronchi branch out independent of each other.

Type II occurs in 24 percent cases, in which the posterior segmental branch arises independently and the other two form a common trunk.

Type III occurs in 14 percent cases, where the anterior branch is independent and apical and posterior are combined.

Type IV occurs in 10 percent cases, where the apical branch is independent and other two form a common trunk.

Type V also occurs in 10 percent cases, where there is absence of posterior segmental bronchus and all branches arise from the apical and anterior bronchi.

Type VI occurs in 2 percent cases, where the apical bronchus is absent and branches arise from the other two segmental bronchi.

The right middle lobe bronchus divides into lateral and medial divisions, which in the majority (70%) arise independently and both are of the same caliber. In 18% to 22% cases, the medial branch is smaller and branches off the lateral bronchus. Less often in 6% to 18% cases, the lateral bronchus is smaller and appears to arise from the medial bronchus. In the right lower lobe bronchus an additional subapical (or subsuperior) segmental bronchus is found in 44% to 60% cases, usually when the apical, lateral or posterior basal segments are poorly developed.[7]

The apical segment branch of the right lower lobe bronchus may arise cephalic to the middle lobe bronchus or rarely stem from the posterior wall of the middle lobe bronchus itself. The most common variations in the three basal segmental bronchi (namely anterior, lateral and posterior basal) is one in which, the anterior segmental bronchus arises most proximally from the lower lobe main stem bronchus and distally, this main stem bronchus divides into lateral and posterior segmental branches. The second most common variation of branching is, where all three segmental bronchi arise independently at the same level. The third common type is the one, in which the anterior and lateral segmental bronchi arise together proximally and the posterior segmental bronchus forms a separate terminal trunk.

Variations on the Left Side

In 75 percent of cases, left upper lobe bronchus divides into an upper division and a lingular bronchus. In the remaining 25 percent cases, the left upper lobe bronchus trifurcates, in which case apicoposterior, anterior and lingular originate simultaneously.[2] The left upper lobe segmental bronchus (Fig. 3.2) namely apicoposterior division usually forms three segmental bronchi, the first supplying the apex, the second supplying the posterosuperior and posteroinferior regions of the apex and the third, the posterolateral region of the upper lobe. In 62 percent cases, the posterolateral segmental bronchus branches off most proximally, with the other two segments forming a common trunk. In 24 percent cases, the common trunk is formed by the posterosuperior and posteroinferior bronchi and the posterolateral branches proximally leave the terminal bronchus to supply the apex of the lobe. In 14 percent cases, the posterolateral segmental bronchus branches from the anterior rather than the apicoposterior bronchus.[7] A subapical or subsuperior segmental bronchus, distal to the origin of the apical bronchus can also be found on the left side. Absence of an upper lobe bronchus is the most common major subtractive anomaly (0.3%).[2,8]

Tracheobronchial Diverticulae or Accessory Cardiac Bronchus

It is reported in 0.09% to 0.5% cases.[9,10] It arises from the medial wall of bronchus intermedius or right lower lobe bronchus and extends inferiorly and medially towards mediastenum or heart and may terminate within the mediastenum. In some cases it may be short and blind ending in a bronchial stump or be associated with small amounts of alveolar tissue (Figs 3.3 and 3.4).[11]

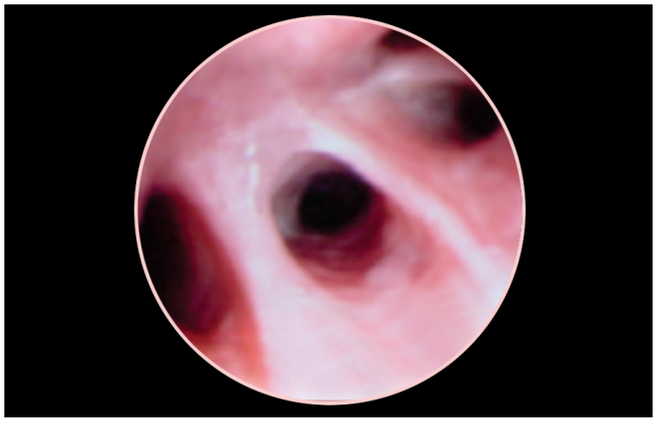

Fig. 3.1: Abnormal right upper lobe bronchus

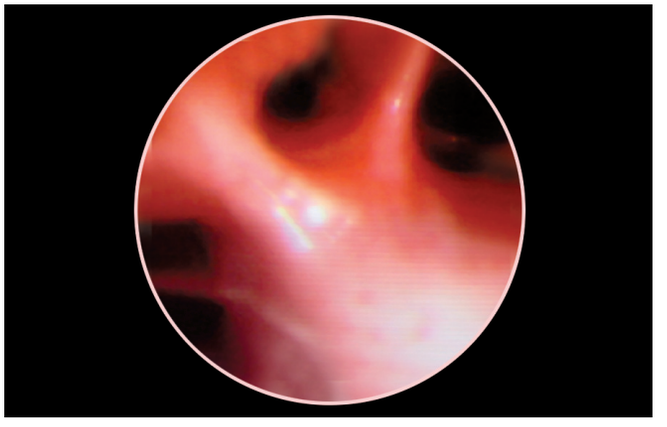

Fig. 3.2: Left upper lobe is like right upper lobe

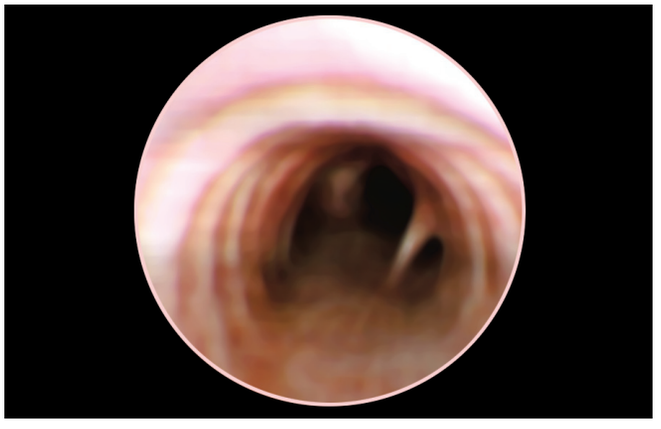

Fig. 3.3: Tracheal bronchus

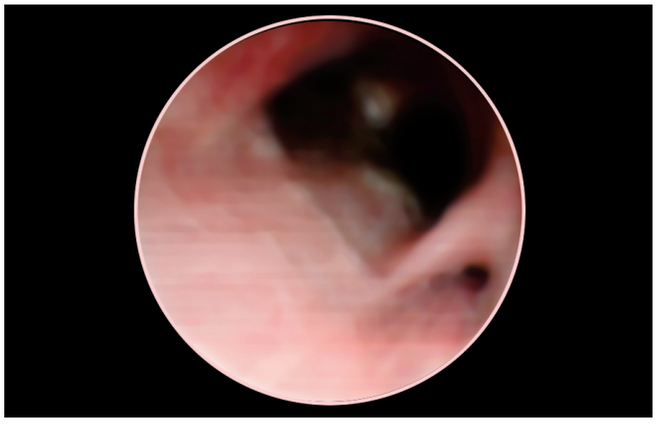

Fig. 3.4: Tracheal bronchus (closed view)

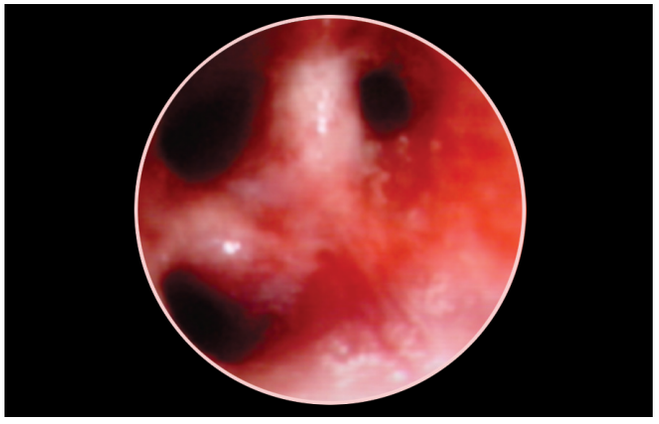

Fig. 3.5: Left upper lobe bronchial isomerism

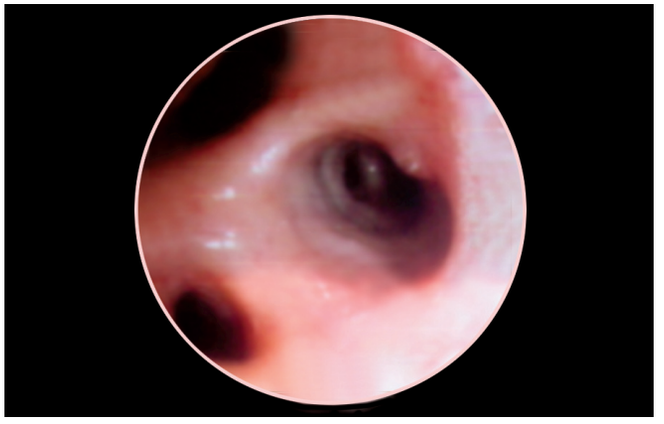

Fig. 3.6: Left upper lobe bronchial isomerism

Bridging Bronchus

Bridging bronchus is a rare anomaly, in which airflow to and from the right middle or right lower lobe passes via an airway that crosses the mediastenum and joins the left main bronchus.[12,13]

Bronchial Isomerism (Situs Ambiguous)

A rare group of developmental anomalous syndrome, in which the normal pattern of bronchial branching and pulmonary lobe formation in either left or right lung is mirrored in the opposite lung, resulting in the same appearance on both sides (bilateral right/left lung). Left thoracic isomerism denotes bilateral bilobed lungs with bilateral hyparterial bronchi. Associated anatomical mirror images of left hilum on right lung is seen and there will be no bronchus intermedius.[14] Although it is an isolated finding, it is frequently associated with a variety of cardiac, splenic and other abnormalities (Figs 3.5 and 3.6).[15-17]

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CHAPTER

4 Machine and Instrumentation

An effective diagnostic or therapeutic flexible fiberoptic bronchoscopy requires the fiberoptic bronchoscope, light source and certain accessories.

FLEXIBLE FIBEROPTIC BRONCHOSCOPE

There are many varieties of bronchoscopes and related equipment, but all are not required to provide optimal bronchoscopy services. The type of bronchoscope required depends on the need and the type of bronchoscopy practice. The bare minimum for performing flexible bronchoscopy to obtain biopsies of lesions in the tracheobronchial tree and therapeutic bronchoscopy, in adults, include: an adult-sized flexible bronchoscope, a light source, several cytology brushes and biopsy forceps, specimen containers, suction apparatus, supplemental oxygen and equipment for resuscitation. A bronchoscopist involved in all aspects of bronchoscopy may require flexible and rigid bronchoscopes of various sizes to accommodate adults as well as pediatric patients. Pediatric bronchoscopy will require flexible bronchoscopes with a diameter of 3.5 to 3.7 mm and rigid bronchoscopes of smaller diameters. The fiberoptic bronchoscope (Fig. 4.1) primarily consist of a long cable instrument shaft of light transmitting and viewing bundles of optical fibers, giving the necessary flexibility to the scope. The instrument shaft also consists of objective lens and lumen for suction and instrumentation.

Proximally, the instrument shaft is attached to a control head, which maneuvers the tip of the fiberoptic bronchoscope. The eyepiece is mounted on the control head, to which a video endoscopy unit, photographic instruments or a lecturerscope (Fig. 4.2) can be attached. On the side walls of the control head, there are the outlet for suction and inlet for the instrumentation channel. The connecting cord for the light source is also attached to the control head. The outer diameter of the instrument shaft, which is inserted into the airways varies from 3.5 to 6.0

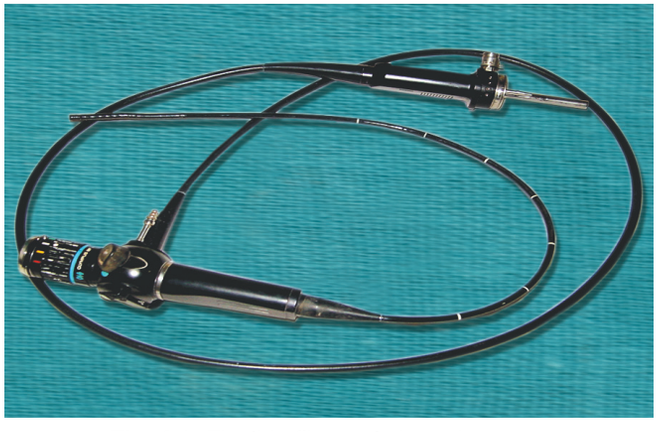

Fig. 4.1: Flexible fiberoptic bronchoscope

Fig. 4.2: Lecturerscope is accessory which can be attached to flexible fiberoptic bronchoscope to help standby doctors to visualize findings

mm. The bending angle of the tip of the shaft may vary up to 180º depending upon the manufacturer.

Ultrathin Flexible Bronchoscope

Ultrathin flexible bronchoscopes have a single lumen and an outer diameter of 2.8 mm at the distal tip.[1] It is useful in the placement and assessment of the endotracheal tubes in pediatric patients with difficult airways.[1] In adults, these bronchoscopes are also helpful in visualizing distal endobronchial lesions, not seen with the standard flexible bronchoscope. If these bronchoscopes have a suction channel, they can also be used to deliver supplemental oxygen.

The ultrathin flexible bronchoscope (Fig. 4.3) has an outer diameter ranging from 1.8 mm to 2.2 mm and a visual angle of 75º, but has no suction capability. They have been used to examine the peripheral airways. They can also be introduced through the working channel of the conventional flexible bronchoscope to perform alveolo-bronchography.

Video Bronchoscope

Video bronchoscope comprises of a flexible bronchoscope to which a video monitor for large screen display is connected by means of a connecting cord. A simple fiberoptic bronchoscope can be used for video bronchoscopy by attaching an adaptor to the eyepiece, which can transmit images to the monitor. The newer video bronchoscopes have a chip [charge-coupled device (CCD)] camera, mounted at the tip of the bronchoscopes and the image is digitized and transmitted by cable into a processor.[2] The image is then reconstructed and viewed on a monitor (Fig. 4.4). The major advantages of the video bronchoscope include the magnification of images on the screen, the ability to teach several students simultaneously and the ability to record the findings for future use. The images can be stored in video formats, 35 mm floppy disks and laser disks.

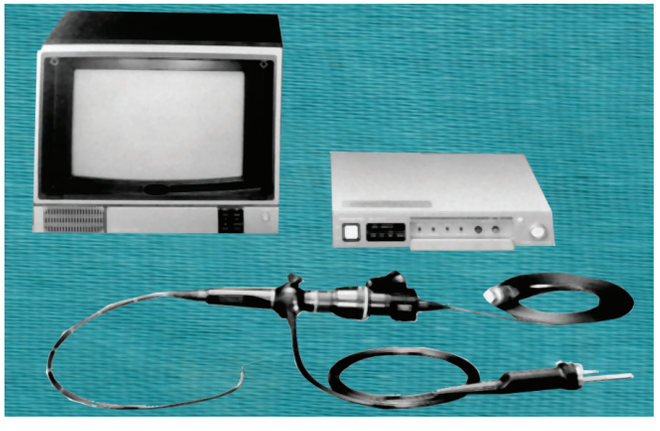

Fig. 4.3: An ultrathin flexible bronchoscope with video monitor and connecting cord

Fig. 4.4: Video bronchoscope system

LIGHT SOURCE

Properly functioning light sources should be available for use in a mobile cart and for still photography, as well as for video bronchoscopy. Extra bulbs and fuses should be available for an uninterrupted functioning of the light source. All modern fiberoptic bronchoscopes use cold light from an external light intensity source, transmitted down the light carrying bundles. Light from the source is conducted to the fiberoptic bronchoscope through a connecting cord of such fibers (Fig. 4.5).

FIBEROPTIC BRONCHOSCOPE ACCESSORIES

Where the fiberoptic bronchoscopes are used for examination and treatment, it is desirable to use the most suitable accessories. Some of the accessories include following.

Biopsy Forceps

Biopsy forceps for flexible bronchoscopes come in many varieties and shapes. They include fenestrated biopsy forceps, oval biopsy forceps (with or without fenestrations) with or without a needle at joint (Fig. 4.6). There are no

Fig. 4.5: Light sources

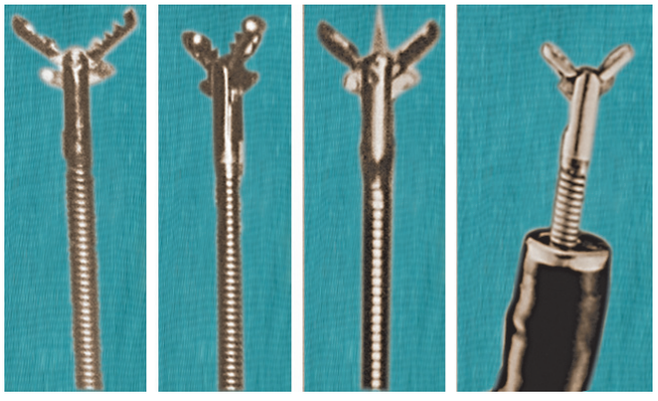

Fig. 4.6: Varieties of biopsy forceps

forceps that can traverse the working channel of ultrathin bronchoscopes. The choice of biopsy forceps depends on the individual bronchoscopist and the performance of the forceps.

The edges of biopsy forceps should be sharp, as dull biopsy forceps crush the tissues and produces artifacts. Where the tissue is smooth and difficult to hold with simple biopsy forceps, a forcep with needle is used to pierce and fix the lesion of interest and then take the biopsy. Larger biopsy forceps do provide larger tissue samples, but the size of the specimen may not significantly alter the diagnosis.[3]

Cytology Brushes

Both disposable and reusable brushes are available. Brushes can be sheathed or unsheathed and may be lined with bristles of varying stiffness (Fig. 4.7). The technique of brushing and preparing cytology smears are far more significant than the type of brush used.[4]

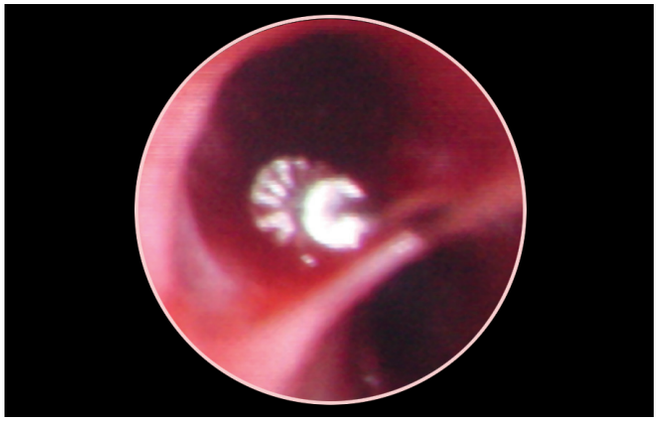

Fig. 4.7: Cytology brush

Bronchoscopic Needle

Bronchoscopic needle are used for transbronchial needle aspiration and biopsy of paratracheal, hilar and subcarinal lymph nodes. Larger needles are used to obtain tissue biopsy and smaller ones are meant for needle aspiration. Both retractable and non-retractable needles, as well as plastic and metallic needles are available. It is recommended to use retractable needles, as they minimize the chance of accidental damage to the inner lining of the bronchoscopes.

Baskets and Claws

Baskets and claws are meant for removal of foreign bodies. Baskets and claws includes urethral basket, grasping forceps (trident type), W-shaped grasping forceps (Fig. 4.8) and magnetic extractor to catch hold of metallic foreign bodies.

Specimen Traps

Specimen traps are used to collect bronchial washings and bronchoalveolar lavage effluent. Separate containers are used to hold glass slides and tissue biopsy specimen.

Other Accessories

Specific bronchoscope accessories are also available, designed for specific uses, such as diathermy cutter, diathermy coagulation tip, injection catheter, scattering and washing catheter. Besides these, suction apparatus, extra tubings, cleaning materials and commonly used drugs are among the miscellaneous equipments, necessary for optimal bronchoscopy.

Photographing Instruments

Photographing instruments is very important to record the findings precisely and objectively. For daily clinical use, the still photograph is the best. For educational purposes, video endoscopy units are more useful for demonstration and recording fine images (Fig. 4.9).

Fluoroscopy (C-arm Image Intensifier)

Fluoroscopy is necessary for accurate localization to obtain a bronchoscopic lung biopsy. Fluoroscopy

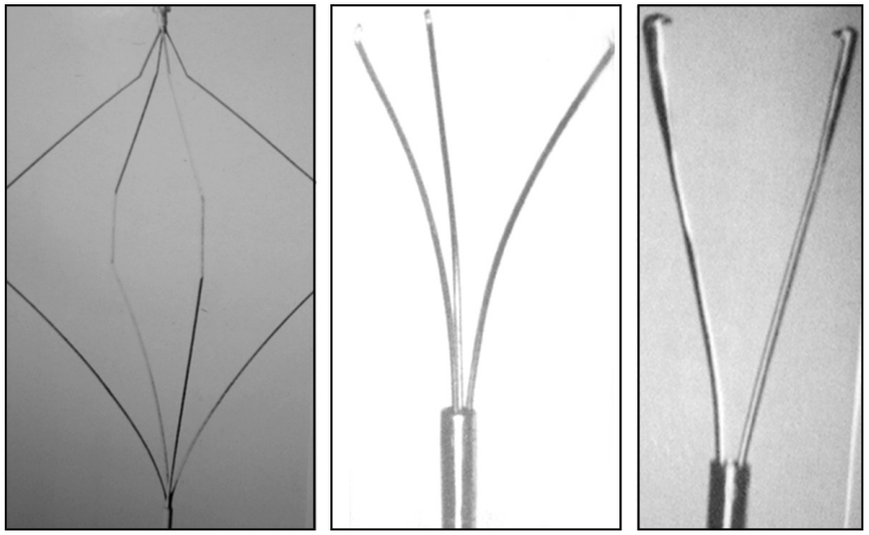

Fig. 4.8: Grasping forceps

Fig. 4.9: Camera

machines are either fixed or mobile. By using fluoroscopy and visualizing the biopsy forceps relative to a lesion or the pleura, the risk of pneumothorax, especially following bronchoscopic lung biopsy is minimized. The incidence of pneumothorax following bronchoscopic lung biopsy is 1.8 percent when fluoroscopy is used and increases to 2.9 percent without fluoroscopy.[5]

Monitoring Equipment

Noninvasive measures such as pulse oximeter, sphygmomanometer and electrocardiographic monitor, provide necessary information about the vital status of the patient and therefore, should be utilized in majority of the patients.

BRONCHOSCOPY SUITE

Ideal bronchoscopy suite should have adequate space for strorage of bronchoscopy-related equipments, prebronchoscopy preparation of patients, performance of the procedure and for postbronchoscopy observation of the patients. The dimensions of a bronchoscopy unit depends upon the type of procedures performed and daily case load. Ideally a bronchoscopy room should measure atleast 5 m × 2.5 m (13 m^2). It should provide adequate sink and work surfaces for cleaning apparatus, clean surfaces for laying out instruments, adequate space for an operator at the bedside, for two assistants and an observer. An oxygen supply and mechanical suction are essential and overhead lighting is

Fig. 4.10: Bronchoscopy cabinets

useful. Among other requirements that should be readily available are, a pulse oximeter, personnel and equipments to provide resuscitation. Proper space for storage of fiber optic bronchoscopes are necessary. Bronchoscopes are stored in a cabinet and should be hung upright (Fig. 4.10). If one has to store the bronchoscope in a curved position, select a curve of maximum possible diameter. If carrying case is used for storage, the shaft of the scope should be placed in such a way that the curve is retained.

MOBILE OR PORTABLE BRONCHOSCOPY UNIT

Not all bronchoscopists perform the procedure in dedicated bronchoscopy suites. In fact, 55 percent of the bronchoscopists in North America performed bronchoscopy at the bedside in the patients room.[6] The bronchoscopists who prefer to provide bronchoscopy service in the patients room should maintain a mobile bronchoscopy unit to facilitate optimal performance of the procedure. Critical care units should also have mobile bronchoscopy units because many patients admitted here frequently require diagnostic and therapeutic bronchoscopy.

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CHAPTER

5

Cleaning, Disinfection and Sterilization of Fiberoptic Bronchoscopes and Other Accessories

The bronchoscope and other accessories are delicate surgical instruments and should be treated with utmost care. The flexible bronchoscope being a very delicate and easily damagable instrument, requires careful handling. It should be borne in mind that bronchoscopy is not a sterile procedure and therefore the need to maintain absolute sterility is not imperative. Proper cleaning of instruments are of utmost importance to prevent both spread of communicable disease and false positive results.[1] Routine care of bronchoscopes involve the cleaning, disinfection, sterilization and proper storage.

CARE OF BRONCHOSCOPES

Cleaning

Failure to mechanically clean the flexible bronchoscope has been responsible for several episodes of contamination. Following each use, the instrument must be cleaned and disinfected or sterilized. Begin cleaning immediately after bronchoscopy to prevent drying of organic debris. Detach all suction ports or biopsy attachments prior to cleaning and inspect instrument for damage. The majority of flexible bronchoscopes marketed currently are submersible instruments. However, the bronchoscopists who are using the older non-immersible models, should follow the manufacturer recommendations. A solution of inert soap is prepared in a wash bowl. The body of the bronchoscope is scrubbed with a gauze and soaked in this solution. The tip of the scope must not be wiped too hard. The channel of the forceps is washed by connecting to the suction apparatus and sucking out the cleaning solution or povidone solution from the tip of the scope. Next all parts of the channel are brushed. It is recommended by most manufacturers that after each use of the flexible bronchoscope a 'leak test' be performed for early detection of damage either to the working channel or to the outer sheath of the flexible bronchoscope.[2] The method of performing the 'leak test' is available in the instruction manual provided with each flexible bronchoscope.

Disinfection

Disinfection can be done manually or with an automated endoscope reprocessor (AER). Disinfection can be done by isopropyl alcohol, glutaraldehyde or phenol. 2 percent glutaraldehyde is the most popular chemical used for this purpose. Submersion of the bronchoscope in 2 percent alkaline glutaraldehyde at 20ºC for 20 minutes destroys all vegetative pathogens, viruses and 99.8 percent of *Mycobacterium tuberculosis*. Cleaning with detergent preceeds disinfection. To remove 100 percent of *M. tuberculosis* the contact time should be 45 minutes at 25ºC.

Following routine cleaning, all bronchoscope biopsy forceps and other instruments are disinfected by 20 minutes immersion in glutaraldehyde. A common practice involves 20 minutes disinfection with 2 percent glutaraldehyde, which is sufficient to kill most non-sporing bacteria, including *M. tuberculosis* and blood-borne viruses.[3] Longer contact times of 1 hour are recommended for some other mycobacteria such as *M. avium* intracellular, encysted parasites and spores.[3] Thorough cleaning will remove most of the problematic and pathogenic microorganisms. Following submersion of the instruments, the exterior and working channel is rinsed with filter tap water followed by 70 percent ethyl alcohol or sterile water and finally dried

by air suction of channel. An automated washing machine, which can wash the outside and inside of the bronchoscope is also available.

Sterilization

Sterilization means the complete elimination of all viable microorganisms including all spores. Sterilization can be performed by submerging the instruments in formaldehyde or using ethylene oxide gas.[4] Ethylene oxide gas is effective against all types of microorganisms, is easily available, noncorrosive and can penetrate through a mass of dry material. Sterilization can also be carried out by ultraviolet (UV) light. For both disinfection and sterilization, one must follow institution-specific guidelines in this regard. The role of the bronchoscope as a vector in the spread of infection from one patient to another and as a cause of pseudoepidemics is a potential risk with improper disinfection and sterilization procedures.[5–7]

Storage and Housing of Fibreoptic Bronchoscopes

Fully dried bronchoscopes are housed in a cabinet for endoscopes. Whenever possible, bronchoscopes should be hung upright. Bronchoscopes, camera systems, accessories should be housed in a room with an even temperature and moisture. Direct sun light or X-rays should be avoided.

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CHAPTER

6 Indications and Contraindications for Fiberoptic Bronchoscopy

The bronchoscope was first used by Killian to extract a tracheal foreign body. Introduction of flexible bronchoscopes have greatly increased the diagnostic and therapeutic utility of bronchoscopy. This chapter views the current indications and contraindications for the use of a flexible bronchoscope in clinical practice.

DIAGNOSTIC INDICATIONS

1. To evaluate lung lesions of unknown etiology that appear on chest X-rays:[1]
   - Persistent/slow resolving/recurrent pneumonia
   - Hilar or mediastinal lymphadenopathy
   - Focal hyperinflation
   - Atelectasis
   - Central mass.
2. To investigate unexplained hemoptysis:
   - Profuse or repeated hemoptysis (especially > 1 week) with or without X-ray abnormality to know the cause and site of bleeding
   - Hemoptysis in aged exceeding 40 years
   - Hemoptysis in young, but chronic smokers.
3. To diagnose lung cancer:
   - Bronchoscopy is the primary diagnostic tool in patients with suspected pulmonary carcinoma or positive sputum cytology
   - It is also used for staging and assessing resectability of central tumors.
4. To investigate unexplained cough, localized wheeze or stridor:[2]
   - Unexplained persistent cough of recent onset to rule out bronchial lesions, foreign body and bronchial distortion
   - Change in character or frequency of cough in patients of chronic bronchitis, especially if the patients smoke tobacco
   - Persistent and recent onset fixed unilateral wheeze
   - Unexplained stridor.
5. To investigate etiology of unexplained paralysis of vocal cord or hemidiaphragm.
6. To investigate unexplained pleural effusion when accompanied with:[3]
   - Hemoptysis
   - Atelectasis
   - Large effusions without contralateral mediastinal shift
   - Failure to reexpand after therapeutic thoracocentesis, before attempting pleurodesis.
7. To evaluate problems associated with endotracheal tubes such as tracheal damage, airway obstruction or tube placement.[4]
8. To obtain material for microbiologic studies in suspected pulmonary infections especially in:
   - Ventilator associated pneumonia[5,6]
   - Suspected opportunistic infections in immunocompromised host[7]
   - Normal host not producing sputum
   - Smear-negative pulmonary tuberculosis.
9. To evaluate the airways for suspected bronchial tear or other injuries after thoracic trauma.[4]
10. To evaluate suspected tracheoesophageal fistula.[8]
11. To determine the location and extent of respiratory tract injury after acute inhalation of noxious fumes or aspiration of gastric contents.[8]
12. To diagnose and evaluate bronchopleural fistula.

13. To diagnose diffuse lung disease such as sarcoidosis, idiopathic interstitial pneumonias, lymphangitic carcinomatosis and others.
14. Extrathoracic indications:
    - Unexplained cervical or axillary lymphadenopathy
    - Unexplained superior vena caval obstruction
    - Unexplained hypertrophic pulmonary osteoarthropathy (HPOA) and/or clubbing
    - Unexplained neuropathies
    - Unexplained endocrine disturbances
    - Unexplained gynecomastia
    - Unexplained voice change
    - Isolated finding of cerebral metastasis.
15. Miscellaneous diagnostic indications:
    - Suspected bronchiectasis to exclude foreign body and bronchogenic carcinoma
    - Bronchography
    - Persistent central thoracic pain
    - To study the airway anatomy
    - Use of ultrasound probes to evaluate peribronchial structures and histology of bronchial wall.

THERAPEUTIC INDICATIONS

1. To remove foreign bodies.[9]
2. To control hemoptysis by:
    a. Lung isolation and airway control.[10]
    b. Double lumen endotracheal tube.[11]
    c. Endobronchial balloon tamponade.[12]
    d. By topical vasoconstrictors and coagulants.[13, 14]
        - Epinephrine (1 : 20,000)
        - Vasopressin (1 mg)
        - Thrombins
        - Fibrin precursor.
    e. Endobronchial laser therapy.[15]
    f. Electrocautery.[15]
3. To remove retained secretions and mucous plugs in patients with respiratory failure and to relieve airway obstruction and atelectasis.
4. Treatment of endobronchial obstruction.
    a. Laser therapy.[16]
    b. Brachytherapy.[17]
    c. Cryotherapy.[18]
    d. Stenting.[19]
    e. Thrombolysis.[20]
    f. Balloon dilatation.[21]
5. To perform difficult intubations in:[22]
    a. Patients of cervical spondylitis.
    b. Patients with dental problems.
    c. Myasthenia gravis.
    d. Achalasia cardia.
    e. Trauma to head and neck.
6. Closure of bronchopleural fistula using silver nitrate, gel foam, fibrin clot and cryoprecipitates.[23]
7. Resection of endobronchial growths.
8. Treatment of endobronchial tumor by insertion of radioactive gold grains and local cytotoxic drugs.[24, 25]
9. Therapeutic bronchoalveolar lavage (BAL) in:
    a. Pulmonary alveolar proteinosis (PAP).[26]
    b. Allergic bronchopulmonary aspergillosis (ABPA).

CONTRAINDICATIONS

Bronchoscopy has been generally shown to be a safe procedure, though the risk of complications are increased in the presence of several conditions such as follows.

Respiratory

1. Uncorrectable hypoxemia: If partial pressure of oxygen (PaO_2) remains less than 70 mm Hg despite maximal oxygen supplementation.
2. Hypoventilation with hypercapnia.
3. Unstable asthma or severe bronchospasm.
4. Tracheal stenosis.

Cardiovascular

1. Recent myocardial infarction within 6 weeks. However recent evidence suggest that bronchoscopy in the immediate postmyocardial infarction period is safe, provided there is no ongoing ischemia.[27]
2. Unstable angina or uncontrolled left ventricular failure.
3. Unstable arrhythmias.
4. Severe hypertension.
5. Severe carotid or cerebrovascular disease.

Neurological

1. Active seizures.
2. Raised intracranial pressure.
3. Severe agitation.

Other Medical Conditions

1. Uncooperative patients.
2. Bleeding diathesis: if bleeding time is more than 15 minutes.
3. Platelet dysfunction or thrombocytopenia. If platelet count is less than 50,000/mm^3, at least 6 to 12 units of platelet should be transfused before or during bronchoscopy.
4. Severe anemia.
5. Cirrhosis with portal hypertension.
6. Uremia: if serum creatinine is more than 3 mg/dL.

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CHAPTER

7 Prerequisites for Performing Bronchoscopy

Prerequisites for performing bronchoscopy are the following:

1. Pre-bronchoscopic evaluation:
   a. Complete medical history, including history of drug allergy and bleeding disorders.
   b. Chest X-ray and full blood count are a must. If any bleeding disorder is present, perform a bleeding profile. If patient is on anticoagulants, it should be stopped 3 days prior to the procedure or alternatively give low-dose vitamin K, international normalized ratio (INR) being maintained less than 2.5.
   c. In patients with chronic obstructive pulmonary disease (COPD), arterial blood gas test is done, if forced expiratory volume in 1 second (FEV1) is less than 40 percent predicted and/or oxygen saturation (SaO_2) is less than 93 percent.
2. Written informed consent must be taken.
3. Patient should have had no oral food or drinks, 4 hours prior to bronchoscopy.
4. Premedications:
   Injection atropine may be given to prevent vasovagal events and to reduce secretions (0.6–1.2 mg intramuscular, 30 to 40 minutes before performing bronchoscopy). Use of atropine routinely[1] seems unnecessary, since such vasovagal events are very unlikely in the supine position and secretions can usually be aspirated. An alternative anticholinergic agent used is glycopyrrolate. Glycopyrrolate with a lower incidence and magnitude of tachycardia is the preferred agent in patients with coronary artery disease.[2] It does not cross the blood-brain barrier, thus lacking the sedation or delirium seen commonly with atropine.
   There is much debate over the need of sedation before and during bronchoscopy.[3,4] Five minutes of conversation with a physician, who is calm and confident can be as effective as a mild anxiolytic during the procedure, whereas an overly sedated patient may hypoventilate and become uncooperative. Most patients are very appreciative of anxiolysis and amnesia. A variety of sedatives may be used such as benzodiazepines (midazolam, diazepam), narcotics (meperidine, codeine, morphine, fentanyl, alfentanil, sufentanil), propofol, droperidol and ketamine.[5] The usual sedatives which are preferred, when indicated are benzodiazepines (e.g. Midazolam 2.0 mg IV, repeated during the procedure if required[6]).
   Prophylactic antibiotics should be given before bronchoscopy to patients who are asplenic, have a heart valve prosthesis or a history of endocarditis.[6] Asthmatics should be premedicated with a bronchodilator before bronchoscopy.

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CHAPTER

8 Topical Anesthesia

LOCAL ANESTHETICS

The most widely used local anesthetic is lignocaine (Xylocaine). Xylocaine spray is shown in Figure 8.1. For bronchoscopy, lignocaine solution strength ranging from 2% to 10% is used and topical analgesia thus induced lasts for 20 minutes.[1] It is usually advised that a total dose of 400 mg should not be exceeded, but in routine practice more may be required. This appears safe, probably because a proportion is expectorated immediately. The British Thoracic Society Guidelines for flexible fiberoptic bronchoscopy limits the maximum dose of lignocaine up to 8.2 mg/kg body weight in adults with extra caution in elderly and those with liver or cardiac impairment.[2] Toxic symptoms appear at plasma levels exceeding 7 µg/mL. The various other local anesthetics used are bupivacaine, benzocaine, procaine, tetracaine and cocaine.

While applying topical anesthesia for either nasal or oral intubation, proper information and sympathetic reassurance must be given throughout to ensure patient confidence and relaxation. There should be no hurry to proceed and time must always be spared for maximum anesthetic action to develop after each application (2–3 minutes). Pain produced, while introducing the bronchoscope may hinder our attempts in gaining patient confidence. It must be noted that topical anesthesia only abolishes surface sensation and pressure, especially on the nasal turbinates, remains very uncomfortable or even painful. The nose is exquisitely sensitive and passing the bronchoscope through a small nasal passage is often the most unpleasant part of the whole procedure. Nevertheless, this is preferred to an oral route, because the patient can cough more comfortably and the fiberoptic bronchoscope cannot be bitten. However at times, oral route for examination has to be used. Instruments for topical anesthesia is given in Figure 8.2.

Fig. 8.1: Xylocaine spray

Toxicity of Local Anesthetics

As already stated, lignocaine is the most widely used local anesthetic for fiberoptic bronchoscopy. Serum levels of lignocaine during bronchoscopy vary widely, but toxic reactions are rarely encountered and usually occurs at serum levels greater than 7 µg/mL. Toxic effects can be systemic or allergic reactions. The rate of systemic absorption of local anesthesia from topical instillation is dependent upon the dosage, age, site of local anesthesia, vascularity, use of vasoconstrictors and physical properties of the drug. Numbness of tongue and circumoral tissue, reflects delivery of low plasma concentrations of local anesthesia. Profound hypotension due to relaxation of arterial vascular smooth muscle or myocardial depression may result, when plasma concentrations of lignocaine reach 5 to 10 µg/mL. At higher plasma concentrations, lignocaine produce predictable

Fig. 8.2: Instruments for topical anesthesia

patterns of central nervous system (CNS) manifestations. Initially patient may express restlessness, tinnitus, vertigo and difficulty with visual focussing. As the concentration in CNS increases, slurred speech, drowsiness and twitching of skeletal muscles may occur. Twitching is first seen on the face and extremities and is usually a premonitory sign to the onset of tonic-clonic seizures. CNS depression follows seizures, concomitant hypotension and apnea may occur. Intermittent conversation with the patient is an excellent method to monitor for symptoms of toxicity.[3] Seizures should be immediately attended by supportive ventilation, oxygenation and treatment of metabolic acidosis. Benzodiazepines are the agent of choice to treat local anesthetic-induced seizures. True allergic reactions to lignocaine are rare and may be due to methylparaben or similar substances that are used as preservatives. Documentation of allergy to the local anesthetic is based on the clinical history and intradermal testing, but it should be noted that intradermal testing may not always provide accurate results.[4,5] In a patient with documented allergy to local anesthetic, a preservative free amide group of anesthetic should be used. In rare cases of a true lignocaine anaphylaxis or in an unsettled clinical situation, general anesthesia is preferable.

TECHNIQUES FOR TOPICAL ANESTHESIA

Six main techniques for topical anesthesia for fiberoptic bronchoscopy are available:

1. Aerosolized—either by atomizer or nebulizer and use of gel preparation.
2. Dropper instillation.
3. Gargling with lignocaine solution.
4. Transtracheal injection.
5. Local nerve block.
6. 'Spray as you go'.

Aerosolized—Either by Atomizer or by Nebulizer and Use of Gel Preparation

Varying degrees of mucosal anesthesia can be obtained in the nose and rest of the upper respiratory tract either by inhaling lignocaine solutions from a nebulizer, by spraying with a hand-held atomizer (Fig. 8.3) or by introducing lignocaine gel. A minor modification of the apparatus can produce preferably larger particles, which when inhaled through the mouth or nose, begin to anesthetize the upper airway. 10 mL of 4 percent lignocaine solution has proved safe. Pressurized lignocaine often produce extreme discomfort and even sinus pain, when used in the nose probably because of sudden increase in intranasal pressure and are therefore best reserved for use beyond the turbinates or via the mouth. The patient is asked to sit in a chair and is given a cup to expectorate oral secretions. With the help of a tongue depressor, either lignocaine or benzocaine is sprayed to coat the uvula and pharynx to decrease the patient's tendency to gag. Laryngeal and epiglottic anesthesia is done by asking the patient to take out his or her tongue as far out of the mouth as possible. The tongue is then wrapped by either the patient or an assistant with a piece of gauze. With the hand-held atomizer with a long plastic cannula, the deeper oropharynx, base of tongue, epiglottis and vocal cords are sprayed with the anesthetic solution progressively

Fig. 8.3: Automizer for xylocaine spray

Fig. 8.4: Topical anesthesia into nostril

and synchronously with inspirations. This usually provokes coughing, which diminishes with each spray, if 2 minutes are allowed between them. Preparation is complete when coughing is no longer provoked. Similar results can be obtained by a nebulizer, but it takes longer time and some patients may feel an unpleasant sensation with it. Lignocaine gel (2%), gently squeezed into the nose until taste is appreciated in the nasopharynx, is much more comfortable and extremely effective (Fig. 8.4). It creates no obstruction to subsequent passage of fiberoptic bronchoscope. The patient's opposite nostril is closed with fingers and the patient is asked to sniff the anesthetic deep into the nasopharynx. Oropharyngeal anesthesia can be obtained by 2% or 4% lignocaine solution via a hand-held atomizer or a nebulizer.

Dropper Instillation

Dropper instillation technique is used with the patient seated erect (indirect laryngeal vision used). The mouth and the pharynx are sprayed with 1% to 2% lignocane (Figs 8.5A and B). A malleable curved adapter is attached to a syringe and used to instill 0.5 to 1 mL aliquots of lignocaine (1%–2%) to the base of tongue, vallecula (to block superior laryngeal nerve endings), epiglottis, vocal cords and trachea. This is a cumbersome and outdated procedure.

Gargling with Lignocaine Solution

Effective anesthesia of glottis and upper airway can be achieved by proper gargling with mucinous solution of lignocaine. However, the patient may accidentally swallow the anesthetic. This method is a little tedious for both patients and bronchoscopists.

Figs 8.5A and B: Topical anesthetic application using xylocaine spray into oral cavity, pharynx and larynx

Transtracheal Injection

Some bronchoscopists prefer the transcricoid injection of lignocaine to anesthetize vocal cords and proximal bronchial tree. The patient is seated erect on a chair and the neck is extended backwards. The area of neck over the cricothyroid membrane is wiped with alcohol. 5 mL of lignocaine (2%) is taken in a 10 mL syringe and entered through cricothyroid membrane with a 23 gauge needle directed downwards. Presence of needle tip in trachea is confirmed by aspirating air. The patient is asked not to make swallowing movements and to refrain from coughing. The anesthetic solution is then rapidly pushed in trachea and the needle must be withdrawn as soon as possible to avoid injury to trachea, as the patient starts coughing. The paroxysms of coughing effectively distributes lignocaine upwards and downwards anesthetizing vocal cords and proximal bronchial tree.

Local Nerve Block

Bilateral superior laryngeal nerve block provides excellent anesthesia of the airway from epiglottis to the vocal cords. A 3 mL of 2% to 4% lignocaine solution is used for this purpose. This procedure is rarely used for flexible bronchoscopy.

'Spray as You Go'

The 'spray as you go' method is an effective method of instillation of local anesthetic through the advancing fiberscope. After anesthetizing the nose and oropharynx, as described above, the distal 10 cm of the shaft of fiberoptic bronchoscope is lubricated with lignocaine gel (2%). After the instrument is successfully inserted through the nose or mouth, 4 percent lignocaine in one or two aliquots of 2 mL (50–160 mg) is instilled under bronchoscopic vision on to the vocal cords and upper airways. Once coughing has subsided, the optic bronchoscope can be advanced between the vocal cords. Thereafter, 2 percent lignocaine solution is instilled in aliquots of 2 mL (40 mg) at the carina, orifices of right upper lobe bronchus, left major bronchus, left upper lobe and lower lobe bronchus and aspirated within 2 to 3 seconds. It should be borne in mind that the total dose of lignocaine used should not exceed the maximum permissible limit to avoid adverse effects.[6]

GENERAL ANESTHESIA

General anesthesia may be desirable for patients who are very apprehensive, in pediatric patients and as part of special techniques such as laser work or stent placement in major airways.

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CHAPTER

9 Fiberoptic Bronchoscopy Procedure

PROCEDURE FOR FIBEROPTIC BRONCHOSCOPY

The best and essential preparation of the patient is careful and sympathetic explanation of the procedure before hand to alleviate anxiety and facilitate cooperation, followed by careful step by step explanation at the time of the procedure. If necessary, a mild tranquilizer (5 mg of diazepam) can be given in the evening before the procedure.

Preparation Immediately Before Insertion

Before starting the procedure, one should choose the most suitable fiberoptic bronchoscope depending upon the condition of the patient and indication of the procedure. Before the actual insertion of the bronchoscope, ensure that the bronchoscope is in good working order and the locking lever is in the off position. Connect the bronchoscope to the light source apparatus. After this step, disinfect the channel of the fiberoptic bronchoscope by aspirating the disinfectant solution three or four times, followed by distilled water and then dry the channel by aspirating air. Having completed these steps, wipe the part of fiberoptic bronchoscope and lens that is to be inserted, with gauze piece moistened in 70 percent ethanol. Polish the lens with the lens cleaner for a good view and adjust the focus. Both eyes of the patient are covered with gauze piece and fixed with tape.

Position of the Patient

The position of the patient depends upon the personal preference of the bronchoscopist and the comfort of the patients. Fiberoptic bronchoscopy can be done in supine position, which is most comfortable. It can also be done in a semirecumbent position with head end raised to an angle of 45° or in upright sitting posture.

Position of the Operator and Holding of Instrument

The position of the operator depends upon his or her personal preference. Some bronchoscopists prefer to face the patient, while others stand at the head end of a lying patient.[1, 2] Face to face contact is valuable in maintaining rapport between the patient and bronchoscopist, while standing behind the head end is advantageous for spatial orientation of the bronchial tree. The technique of holding the fiberoptic bronchoscope depends upon the type of instrument available. Most commonly the bronchoscope is held by the left hand. The body of the instrument is held by the second, third, fourth fingers and palm, while the control knob can be moved up and down, by the thumb. The index finger is placed near the proximal end of the suction channel to seal it for aspiration as and when necessary (Fig. 9.1). Rotation of the bronchoscope tip is achieved by rotating the wrist and thereby the whole instrument. The free hand is used to hold steady advance and withdraw the shaft, as well as to maneuver the biopsy forceps and brushes to their targets. This will greatly reduce nasal discomfort to patients. The fiberoptic bronchoscopy in progress is shown in the Figures 9.2 and 9.4 to 9.6.

Routes for Bronchoscopy

The fiberoptic bronchoscope can be inserted nasally, orally, through a nasotracheal or orotracheal tube, through a tracheostomy stoma or through a rigid bronchoscope.[3–5]

Fig. 9.1: Correct method of holding the fiberoptic bronchoscope

Fig. 9.2: Fiberoptic bronchoscopy in progress

Fiberoptic Bronchoscopy Via Transnasal Insertion

Transnasal insertion method is very useful, if the patient has a strong pharyngeal reflex or if the patient is comatose and it is difficult to keep the mouth open or if postoperative bronchial toilet is necessary.[4] Widest of the nostrils is anesthetized with lignocaine gel or spray. The shaft of the bronchoscope is lubricated with lignocaine gel. The tip of the bronchoscope is passed through the nostril, directly backwards and not obliquely upwards. It is then advanced through the inferior meatus between inferior turbinate and the floor of the nose. As the back of nose is reached, the fiberoptic bronchoscope tip is angled more caudally, to pass through the nasopharynx into the space behind the tongue. Be extremely cautious, because bleeding can occur if there is damage to the nasal mucosa.

Fiberoptic Bronchoscopy Via Transoral Route without a Tracheal Tube

After instructing the patient to relax and let his/her shoulders sag, he/she is asked to stick out his/her chin and put out the tongue. A plastic mouthpiece is inserted to protect the instrument from an inadvertent bite. The tip of the instrument is inserted through the mouthpiece (Fig. 9.3) and passed

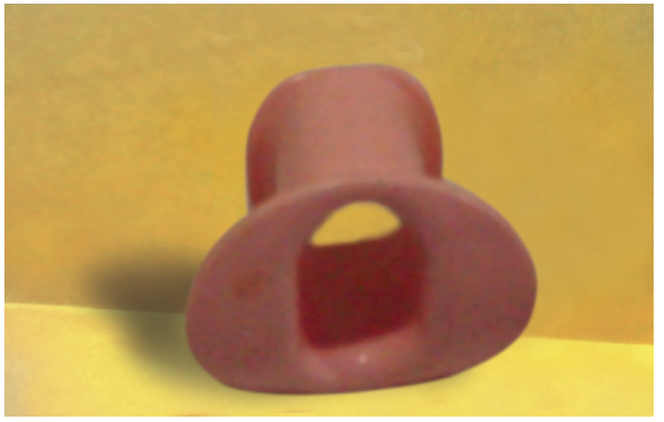

Fig. 9.3: Mouthpiece

over the tongue along the midline of the body. The tip of the fiberoptic bronchoscope is then deflected by angle of 50° to 60°. Upon reaching the epiglottis, the tip is straightened and advanced, when the vocal cords come into view.[5]

Fiberoptic Bronchoscopy Via Tracheostomy or Endotracheal Tube

In an intensive care setting, the bronchoscope can be used either for diagnosis or as a therapeutic measure, to remove accumulated secretions. The bronchoscope can

be inserted easily through an already placed endotracheal or tracheostomy tube. Advantage of inserting a fiberoptic bronchoscope via a tracheostomy site is that the vocal cords are bypassed and the bronchoscope directly enters the trachea. In fiberoptic bronchsocopy via transoral insertion with a endotracheal tube, a suitable curve is made in the endotracheal tube using a stylet. Then, under laryngoscopic guidance, the tube is inserted and the stylet is then withdrawn. The tracheal tube is fixed to the patient's face with adhesive tape and the bronchoscope is inserted.

Negotiating the Larynx and Tracheobronchial Tree

It may be necessary to aspirate secretions obscuring the view. Once the epiglottis has been identified, the glottis is usually visible behind and beyond it. If difficulty is encountered in getting behind the epiglottis, it may be possible to pass the bronchoscope tip laterally and posteriorly alongside the epiglottis and then turn the tip, medially to curl over onto the dorsal surface of the epiglottis. The glottis and vocal cord are sensitive areas and care should be taken to avoid undue irritiation by bronchoscope tip while anesthetizing this area. One has to watch for cardiac dysarrhythmias induced by vagal stimulation.

Once the larynx is in view, vocal cord movements are studied during phonation by asking the patient to say either 'see' or 'ee'. Inequality of movements of the cords suggest recurrent laryngeal nerve palsy. Before the bronchoscope is inserted between the cords into the trachea, the patients should be informed that this will cause cough, transient breathlessness and that he/she should not attempt to speak. The pharynx, epiglottis and cords are inspected for abnormalities especially tumors. Before negotiating the glottis, adequacy of anesthesia must be checked by trickling 2 percent lignocaine solution onto the cords. If coughing is produced, 2 minutes must pass before more lignocaine can be applied. The fiberoptic bronchoscope is passed slowly and very gently through the posterior part of the glottis during quiet inspiration. If this causes coughing, withdraw the bronchoscope immediately from the vocal cords and more anesthetic solution should be applied. Once the glottis is passed, 2 mL of 2 percent lignocaine solution in a 5 mL syringe with 3 mL of air should be sprayed as necessary via the suction channel. Wait for a minute or so for the patient to become accustomed to the presence of bronchoscope in the trachea. A further bolus of 2 mL of 2 percent lignocaine may be required, if persistent coughing occurs.

The trachea should be inspected for the appearance of the mucosa and abnormally increased or decreased mobility of its walls. Similiarly, the carina should be examined for its sharpness and mobility. Normally, the carina becomes shorter and thicker during coughing. Abolition of this variability may indicate infiltration by carcinoma or enlargement of a subcarinal lymph node. Before proceeding, the bronchoscopist must keep in mind limitations in the anatomical knowledge of the tracheobronchial tree. One's position in the peripheral bronchial tree can only be appreciated by knowing how one got there. Withdrawing to the carina for reorientation helps in difficult circumstances. The examination is carried out in a methodical, routine fashion to ensure that nothing is missed. Both right and left bronchial trees must be systematically examined, even if the chest radiograph shows a unilateral lesion. It is recommended that the normal side should be inspected first. Once within the bronchial tree, the manipulation is similar whatever method of insertion be chosen. Forced angulation, twisting or flexing should not be attempted as it can damage guidewires, optical fiber bundles or both. The fiberoptic bronchoscope should never be withdrawn, while the control knob is in locked position.

Right Bronchial Tree

To examine the right bronchial tree, the bronchoscope is guided into the right main bronchus. The right upper lobe orifice, usually lies just below the carina on opposite lateral wall. It is advisable to give an additional 2 mL of 2 percent lignocaine into the upper lobe before it is inspected, as the previous dose of lignocaine frequently fails to reach it, due to its angulation. The orifice is now entered and the segments and subsegments are examined. The anterior segment lying ventrally and posterior segment lying dorsally, are easy to inspect without too much of manipulation of the bronchoscope tip. The apical segmental bronchus is more difficult to enter. The patient is asked to hold the breath at full inspiration after taking few deep breaths, when apical segmental orifice will be more easily seen, with the tip of the bronchoscope bent maximally in upward direction towards the head. The right middle lobe bronchus arises ventrally from the bronchus intermedius and extend obliquely downwards. It can be inspected up to the subsegmental level. The bronchoscope is then withdrawn back into the bronchus intermedius and

rotated dorsally until the orifice of the superior segment of right lower lobe is seen, lying at the same level as of the middle lobe. This segmental bronchus branches at a 90° angle from the bronchus intermedius and entry into it can be aided by asking the patient to hold breath in full inspiration. The remaining four segmental orifices of the right lower lobe, lie several centimeters distal to the superior segment. They all extend downward and are really extensions of the main bronchus, so little difficulty is usually encountered in entering them.

Left Bronchial Tree

After withdrawing the bronchoscope back to the carina, the left bronchial tree is inspected by rotating the bronchoscope to the left. The left main bronchus is longer than the right and also deviates more laterally. The secondary carina between the upper and lower lobe orifices is a useful landmark. The upper divisions of the left upper lobe bronchus is next examined by turning the tip of bronchoscope upwards with maximum flexion. This is the most difficult bronchus to enter and can be made easier by asking patients to take a deep breath. The anterior and apical posterior segments are then examined. The lingular bronchus is usually an extension of the upper lobe bronchus and descends downwards dividing into superior and inferior segments. The bronchoscope is withdrawn back to the secondary carina and the left lower lobe is examined. The superior segmental bronchus arises dorsally almost at the level of the secondary carina. It is located by turning the tip of bronchoscope posteriorly and again if difficulty is encountered in entering it, the patients is asked to breath in full inspiration. The basal segments of the left lower lobe do not pose any difficulty to examine, keeping in mind that the anterior and medial basal segments are usually fused into a single orifice.

Examination of an average, normal tracheobronchial tree has been described. Variations in the branching of bronchi are frequently encountered and should be borne in mind, especially if the mucosa looks normal. At more peripheral levels, individual bronchi or combinations of bronchial orifices cannot be recognized by individual appearances alone because they usually look alike and variations are common. They can only be identified by recalling the route, the bronchoscope had taken to get to that point in the bronchial tree.

Manipulating the Bronchoscope

Mastering the ability to use a fiberoptic bronchoscope comes with practice. Although, many useful hints are often given, but there is no substitute for time and practice spent in handling the instrument. For a experienced bronchoscopist, guiding the instrument with coordinated movements of the wrist, thumb and fingers of the right hand, as well as the forward and backward movements of the left hand occurs at a subconscious level. Although, the need for practice cannot be over emphasized, a few general comments should be useful to the beginner.

When advancing the instrument, the tip must as far as possible, be in the center of the lumen of the airway. This is achieved by tiny coordinated movements of the right wrist and thumb. Failure to achieve this will cause excess coughing and bleeding. A cycle of coughing once commenced leads to repeated irritation of the mucosa. If this occurs there is no alternative, but to withdraw the bronchoscope, instill more local anesthetic and wait until the coughing stops, before advancing again. Insertion of the bronchoscope into the segmental or subsegmental bronchi must be done with care. In an average male adult, a 5 mm diameter instrument may reach segmental orifices, but will be too large to enter them. However, it is often possible to enter subsegmental orifices with a 4 mm diameter bronchoscope. Force must never be used to advance or rotate the instrument at any time, particularly at the segmental and more peripherals levels. Apart from causing trauma to

Fig. 9.4: Fiberoptic bronchoscopy and simultaneous viewing with lecturerscope

Fig. 9.5: Video bronchoscopy lab

Fig. 9.6: Video bronchoscopy in progress

the bronchial wall, the angling mechanism of the tip may get damaged. The tactile sensation of increasing resistance to movement of the bronchoscope must not be ignored. During bronchoscopy, vision is frequently obscured by soiling of the distal objective lens by secretions, pus and blood. Several methods may be used to clean the lens. The tip of the bronchoscope can be wiped on the bronchial wall or carina, while applying suction. The channel can be irrigated with 5 to 10 mL of saline and then aspirated, while the patient coughs. These may clean the lens. If these maneuvers fail, usually because of adherent blood clot, it is quicker and easier to remove the bronchoscope, clean it and reinsert it. Suction is often used indiscriminately, because its side effects are not fully appreciated. If the aspiration pressure is too great, the bronchial mucosa is sucked into the fiberoptic bronchoscope suction channel and submucosal petechiae may arise even in patients with normal mucosa. In those patients with friable mucosa due to infection or neoplastic diseases, frank bleeding may occur. Prolonged suction in smaller, peripheral airways into which the fiberoptic bronchoscope tip is wedged will cause collapse of the segmental or subsegmental bronchi, which have relatively poor supporting cartilage. With this collapse, spasm of the bronchial wall muscle is liable to follow. Brisk intermittent suction is not only more efficient at removing secretions, but it also causes fewer side effect. The pressure of the suction can also be varied by partially covering the hole, over the suction channel with thumb or finger.

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CHAPTER

10 Specimen Collection

Much of the value of bronchoscopy depends upon the diagnostic yield from accurate specimen collection, preparation and examination. Specimen collection and initial preparation are the responsibility of the bronchoscopist. It is vital that a thorough discussion with laboratory staff to be done to establish the optimum methods of specimen collection. Great care and gentleness are essential during all procedures for the sake of both patients and instruments. Time and money is involved in processing each specimen and only specimens, which significantly improve diagnostic accuracy be selected. The range of specimens needed will vary with the clinical problems. The specimens that can be obtained from the endobronchial tree are endobronchial biopsy, brush smear/biopsy, bronchial aspirate/washing, bronchoalveolar lavage (BAL), transbronchial needle aspiration (TBNA) and transbronchial lung biopsy (TBLB).

BRUSH BIOPSY

Endobronchial brush biopsy (Fig. 10.1) method is useful in small bronchi where the forceps will not open or when used blindly, where a tumor out of vision is suspected. Brushes are much more flexible than biopsy forceps. Brushes are available in various sizes (2 mm, 5 mm and 7 mm), types (sheathed and unsheathed) and reusable or disposable. Sheathed brushes are usually disposable, while unsheathed brushes are reusable. Brushes with large bristles give a higher cell yield than those with smaller and more evenly arranged bristles. Old brushes with broken bristles should be discarded and reusable ones should be cleaned carefully after each procedure to prevent cross-infection and contamination of samples. Preferably those cytology brushes, which have a protected sheath should be

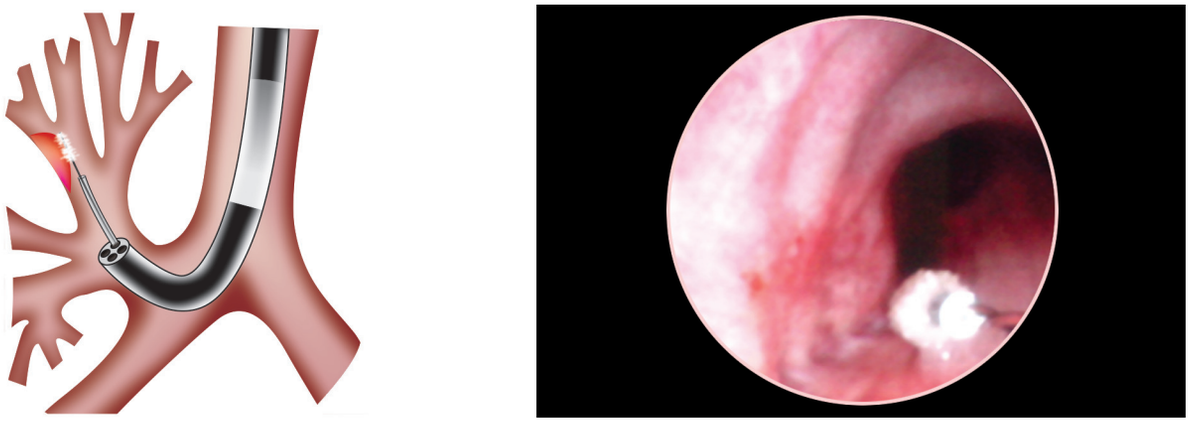

Fig. 10.1: Endobronchial brush biopsy

used. The brush is held within its polythene sheath, which is passed down the suction channel. The sheathed brush is advanced to the required site through the suction channel, using repeated short advancing strokes. The brush when visualized is positioned above the area for sampling and the tip of the fiberoptic bronchoscope is maneuvered, so that the brush is pressed lightly onto the lesion and then advanced. Withdrawn several times by pushing the sheath and protruding brush in and out of the suction channel. The brush is then withdrawn into its sheath and the sheath with the enclosed brush are withdrawn from the suction channel. It is preferred to withdraw the bronchoscope from the patient, with the brush protruding from it, to reduce the chance that cytological material will be left in the bronchoscope channel.

Brush biopsy can also be performed on localized peripheral lesions, which are not endoscopically visible. Fluoroscopic control of the placement of the brush, while not essential, does improve yield. The sheathed brush is inserted into the appropriate segmental bronchus and advanced under fluoroscopic control to the lesion. The position of the brush should be confirmed by turning the patient through 90° angle or by biplane fluoroscopy to ensure that the brush does not lie in front or behind the lesion. Brushings are then done in the usual way. Several bronchi may lead to the area of lesion and ideally all should be brushed. If the lesion is not visible on fluoroscopy or if fluoroscopy is not available, then the brush is advanced to the area, which the lesion is seen to occupy on a chest radiograph.

The slides for cytology should be prepared immediately, because drying of the specimen in air alters cell morphology. The bristles of the extended brush are pressed against a clean glass slide and rubbed across the surface. The brush should be rubbed in a circular fashion rather than side to side, as air drying is more likely to occur at the edges of the smear. The slides should be fixed immediately in absolute alcohol. An alternative method of handling brush specimen, which avoids the problem of air drying is to agitate the brush in a tube of 0.9 percent saline solution. This fluid then can be centrifuged and smears are prepared from the sediments obtained. Diagnostic yield by this method is less, as compared to when brushings are transferred directly to glass slide. The threshold for diagnosis of pneumonia rather than airway colonization is 10^3 colony forming units (CFU)/mL in respiratory secretions obtained by protected sheathed brush (PSB).[1] The diagnostic yield with brushing from a visible malignant process is as high as that of biopsy and may reach upto greater than 90 percent. False positive results (for malignant cells) are low and usually reported in 1% to 3% of cases. The bronchial brushings are indicated for the diagnosis of malignancy and for infectious agents, (e.g. tuberculosis [TB], *Pneumocystis carinii, Cytomegalovirus* [CMV], fungi).

BRONCHIAL WASHING

The simplest and least traumatic method for obtaining specimens for cytology is to instill normal saline through the channel of the fiberoptic bronchoscope into the region of the airways under suspicion and to aspirate into a trap connected to suction tubing. Bronchial washings are suitable for assessing cytology type of malignant cells and obtaining culture material for the diagnosis of fungal and mycobacterial infections, as well as to make cytological diagnosis of certain infections such as *Pneumocystis,* CMV. Usually 5 to 10 mL of saline is introduced with each wash and about 25% to 50% of this can be aspirated. Upto 60 mL is commonly used and a yield of 5 to 10 mL of aspirate is usually sufficient. It is preferred to perform brushings before washing, as material, which is dislodged by the brush can be aspirated into the trap. Since, washings are collected throughout the procedure, secretions from examined lobes, as well as the oral cavity and upper respiratory tract contaminate it. A minimum of 15 mL undiluted fluid should immediately be sent to the cytology laboratory for processing. If rapid transport to the cytology laboratory is not possible, the sample should either be refrigerated or be placed in a specimen bottle containing equal volume of a fixative.

ENDOBRONCHIAL FORCEPS BIOPSY

Endobronchial forceps biopsy (Fig. 10.2) procedure is usually performed under local anesthesia with the patient in supine position. Endobronchial biopsies are indicated in centrally located neoplasms and for the diagnosis of peribronchiolar granulomas. Several shapes and sizes of biopsy forceps are available. Smaller forceps, because of their flexibility, are better adapted for taking biopsies from

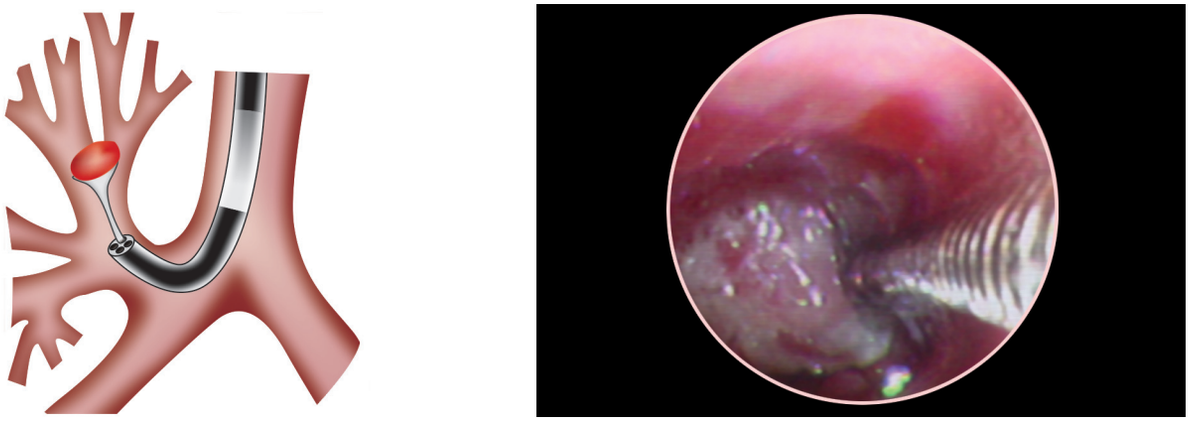

Fig. 10.2: Endobronchial forceps biopsy

the upper lobes and apical segments of the lower lobes, where the tip of the bronchoscope has to be flexed to an acute angle. Larger forceps can be used for other, more easily accessible bronchi.

Most forceps have a window on each cup to reduce artifacts by limiting tissue pressure. Before attempting biopsies the channel should be flushed with normal saline to avoid soiling of the distal lens. With the area of interest in view, the forcep are inserted into the biopsy port with the jaws closed and then advanced with repeated short strokes. When the forceps jaws protrude about 5 mm from the distal end of bronchoscope, the jaws are opened and advanced onto the lesion. The jaws are then closed and biopsy taken by gently pulling back the forceps until the specimen is removed. Necrotic material often overlies tumors and it may require piecemeal removal with the forceps before a biopsy of histopathological value can be obtained. The fiberoptic bronchoscope's tip is returned to the neutral unflexed position and the scope is then withdrawn. At least 3 or 4 good biopsies should be taken and each in turn is removed by agitating the open forceps in a small container containing 10 percent formalin or can be dislodged using a 25 or 22 gauge needle into 10 percent formalin solution. The overall diagnostic yield of biopsies of tumors that are bronchoscopically visible, ranges from about 90% to 96%.[2] Biopsy brushing together gives a yield of over 97 percent. Biopsy and follow through washing gives a yield of 95 percent for malignant etiology.[3] Endobronchial biopsy, bronchial aspirate and postbronchoscopic sputum smear cytology combined together yielded 71 percent diagnosis bronchogenic carcinoma in 332 endoscopically visible lesions in one of the studies done by author himself in India.[4]

Curette Biopsy

When the lesion to be biopsied is in a segmental or subsegmental bronchus, it can be biopsied with a curette, as it is not possible to open the forceps jaw in such small bronchi. The curette is also useful, if the lesion lies distal to the bronchial stenosis. The curette head has some mobility, as its cutting tip can be flexed to approximately 90° and rotated towards the lesion. The curette is then scrapped over the lesion to obtain the specimen. Before withdrawing, the tip of curette should be straightened, to prevent damage of fiberoptic bronchoscope channel lining. With curette biopsy, there is a greater risk of perforation or tear of the bronchus, as well as bleeding from the mucosa than with forceps biopsy.

TRANSBRONCHIAL NEEDLE ASPIRATION

Transbronchial needle aspiration (TBNA) (Fig. 10.3) is a modality that allows us to sample tissues from the deeper submucosa, as well as from the close extraluminal areas of the endobronchial tree. Tissues can be obtained for either cytological or histological examination. Indications for TBNA include to establish the diagnosis or to stage known or suspected bronchogenic carcinoma presenting as mediastinal or hilar lymphadenopathy, for endobronchial necrotic tumor, extrinsic compression of airway by peribronchial process, submucosal disease, peripheral nodules or masses, diagnosis and/or drainage of mediastinal cysts and abscesses. The needle is inserted with the bevelled end secured within the metal hub, when passed

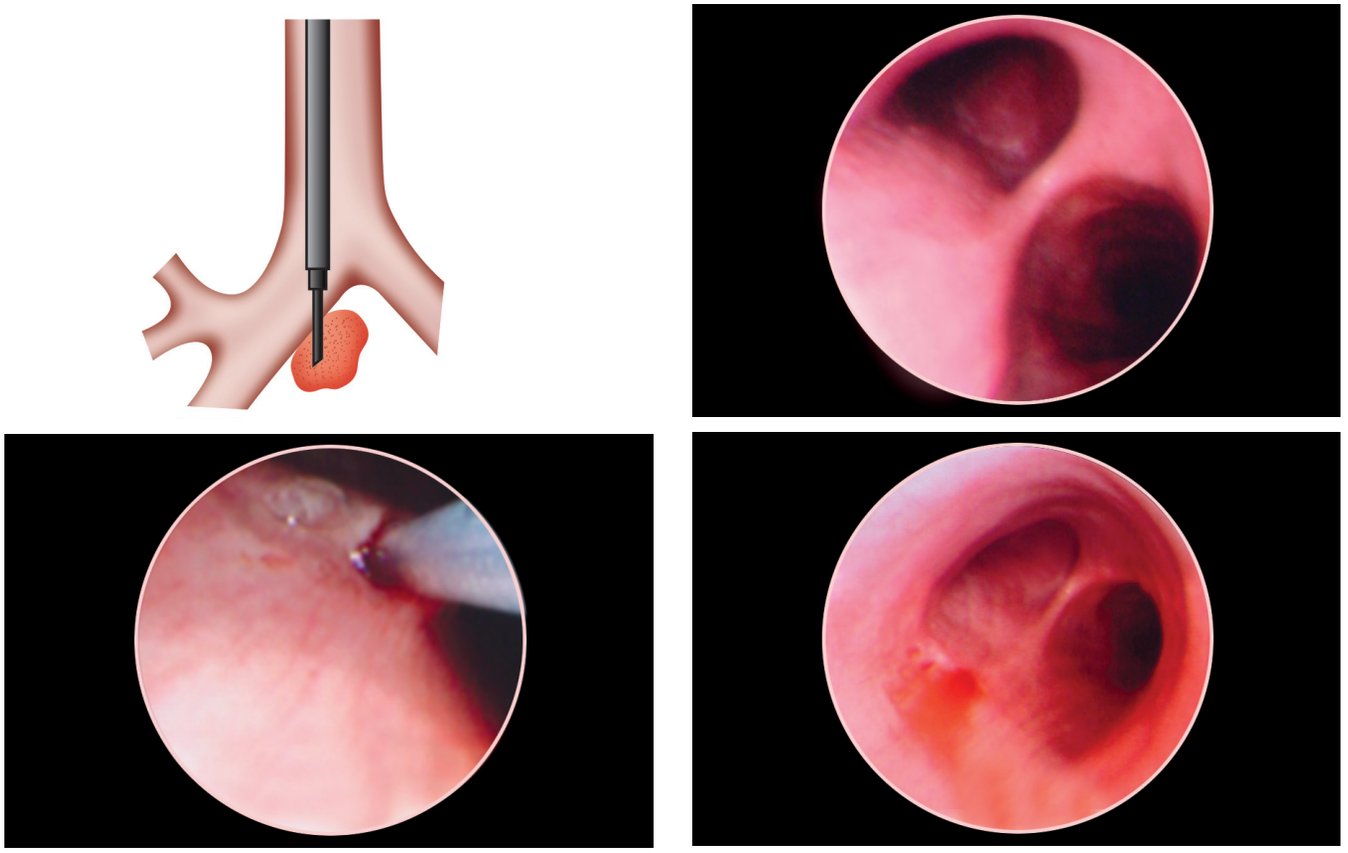

Fig. 10.3: Transtracheal needle aspiration

through the working channel. To prevent damage to the working channel of the bronchoscope, the bronchoscope should be kept as straight as possible with its distal tip in the neutral position. The needle is advanced and locked in place, only after the metal hub is visible beyond the tip of bronchoscope. The bronchoscope is then advanced to a target area and the tip of the needle is anchored in the intercartilaginous space. The following array of techniques can be used to insert the needle through the airway wall jabbing method, hub against the wall method, piggy back method, cough method. All these techniques can be used alone or in combinations. With the needle inserted, suction is applied at the proximal end using a 20 mL syringe.

When there is no blood in the aspirate, the catheter is agitated to-and-fro with continuous suction. The needle is withdrawn from the target site after releasing suction. The tip of the bronchoscope is straightened and the needle is pulled out of the bronchoscope in a single smooth fashion. The specimen for cytology is extruded from the needle, by utilizing air pressure from a 20 mL syringe. The material thus obtained is smeared with the help of another glass slide and placed into 95 percent alcohol solution.

The predictors for positive TBNA include presence of an endoscopically visible endobronchial tumor, particularly involving the right upper lobe, subcarinal lymph node size is greater than 2 cm and carinal involvement. The sensitivity for cytological analysis is 64% and 53% with a 19 gauge and 22 guage needle[5] respectively. The sensitivity of combined cytology and histology samples obtained with a 19 gauge needle is 86 percent. Complications include fever, transient bacteremia, bleeding, pneumothorax and pneumomediastinum.

BRONCHOALVEOLAR LAVAGE

Bronchoalveolar lavage (BAL) (Fig. 10.4) is the instillation of small quantities of saline directly into the distal airways and recovering the aspirate for analysis. A practical

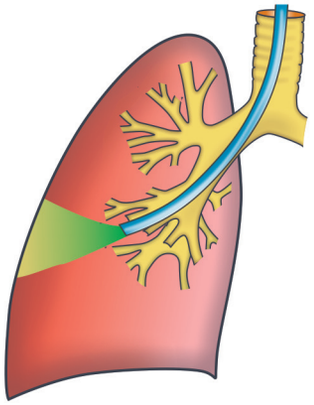

Fig. 10.4: Bronchoalveolar lavage

common method of BAL has not been established yet and differs from one institute to other. BAL differs from bronchial washings, which imply aspiration of secretions or small amounts of instilled saline from the larger airways. BAL allows the recovery of both cellular and non-cellular components from the epithelial surface of lower respiratory tract.

Indications

Interstitial lung diseases (ILD) (sarcoidosis, idiopathic interstitial pneumonias, collagen vascular diseases and others), hypersensitivity pneumonitis, pneumoconiosis (asbestosis, berylliosis, silicosis), bronchiolitis, drug-induced lung disease, histiocytosis, pulmonary alveolar proteinosis, chronic eosinophilic pneumonias, occult pulmonary hemorrhage, fat embolism, malignancy (presenting as peripheral opacity beyond the visual range of fiberoptic bronchoscope), infections (tuberculosis, especially in smear negative patients presenting with suspicious looking peripheral infiltrates, opportunistic infections such as pneumocystis and others).

Contraindications

There is no absolute contraindication to BAL. Relative contraindications include myocardial infarction (MI) within 6 weeks, forced expiratory volume in one second (FEV_1) less than 800 to 1,000 mL, resting oxygen partial pressure (PaO_2) less than 70 mm Hg, uncorrected oxygen saturation of 90 precent with supplemental oxygen, moderate to severe asthma, hypercapnia, serious cardiac arrhythmia, uncorrected bleeding diatheses and hemodynamic instability.[6]

Bronchoalveolar lavage is performed after routine inspection of the tracheobronchial tree, before biopsy and/or brushings in order to avoid contamination of the recovered fluid with excess blood, which would alter the concentration of cellular and non-cellular components (Fig. 10.5). To perform BAL in diffuse lung diseases, the bronchoscope is wedged into a subsegmental bronchus preferably into the middle lobe or lingular bronchus, since a greater volume of fluid can be retrieved from these sites. Others prefer to sample lateral basal segments of the lower lobes. The choice of site for BAL may be influenced by the radiographic disposition of the shadowing when the radiograph is abnormal. However, in localized diseases, specific area of interest is identified with chest radiograph/computed tomography (CT) scan. Bilobular lavage can be done in some diffuse lung diseases. Sterile, non-bacteriostatic normal saline is used either at room temperature or warmed to 37°C to prevent coughing and buffered to a pH of 7.4. Aliquots of 20 to 50 mL saline is injected down the suction channel of the bronchoscope. The fluid is then removed from the lung by the use of 50 to 60 mm Hg of negative pressure from a usual suction apparatus and collected into 50 to 100 mL specimen traps. The trap should be made of material to which the cells are poorly adherent such as polyethelene or polycarbonate. The lavage procedure is repeated to a total of 3 to 5 times in each site usually for a total of 150 to 200 mL per site. The patient should inhale and exhale deeply during fluid aspiration. Suction should not be greater than 50 to 80 mm Hg, as it may cause distal airway collapse and lead to inadequate returns.

There is some controversy with regard to, whether the return from the initial aliquot should be processed separately or even discarded all together. However, there is no evidence that inclusion of this initial material significantly affects the final cellular analysis. During 1 to 2 hours following

Fig. 10.5: Collection of bronchoalveolar lavage fluid

the procedure, it is safe to monitor and administer nasal supplemental oxygen if needed, but many patients may not require oxygen.

Normal Composition of BAL

Normal composition of BAL comprises of:

1. Alveolar macrophages (92 ± 5%).
2. Lymphocytes (7 ± 1%).
3. Polymorphonuclear neutrophils (< 1%).
4. Eosinophils (< 1%).
5. Basophils (< 1%).
6. Mast cells (< 1%).
7. 73 percent of lymphocytes are T cells and 7 percent are B cells, while rest 19 percent are null cells.
8. Cluster of differentation (CD) 4^+ represents 39% to 48% of lymphocytes, while CD 8^+ represents 23% to 28%. The ratio of CD 4^+ : CD 8^+ = 1.6 to 1.8.
9. The concentration of glucose in BAL fluid is approximately 40 µg/mL and protein is 0.06 mg/µL.

Evaluation of Results

Lavage results are not considered valid, if:

1. The patient has purulent secretions in the airways.
2. The bronchoscope is not maintained in the wedged position during the lavage procedure.
3. The volume of fluid recovered is less than 40 percent of the volume infused.

Excessive lignocaine should be avoided as it may impair the *in vitro* function of the immune cells recovered.[8] However, it has been shown that BAL specimens containing lignocaine were not high enough to inhibit the culture and growth of pathogens.

Protected Bronchoalveolar Lavage

Protected BAL (PBAL) is an effective way to collect uncontaminated specimens from lower airways. For this, a protected transbronchoscopic balloon tipped catheter is used. It has two lumens, the larger one for irrigation and aspiration and the smaller one communicates with the latex balloon at the distal end of the catheter and allows optimal occlusion at the level of the third generation bronchi. For quantitative BAL, a threshold of 104 CFU/mL is used for the diagnosis of pneumonia, reflecting a concentration of 10^5 to 10^6 bacteria/mL in the original specimen.[9] Sensitivity and specificity for the detection of pneumonia by quantitative BAL culture ranges from 75% to 100% and 70% to 100%, respectively.[10]

Complications related to BAL include, post BAL fever or delayed febrile response (most common) that is not due to pulmonary infection, but a transient pyrogen effect that can be treated with antipyretics. The incidence of post BAL fever is related to the number of lobes lavaged and the total volume of fluid instilled into each lavage site. BAL also results in hypoxemia, a small fall in forced expiratory flow rate (FEFR), FEV1, forced vital capacity (FVC) and transient increase in pulmonary infiltrates. Other side effects include bradycardia and hemoptysis.

TRANSBRONCHIAL LUNG BIOPSY

The ability to obtain lung tissue without subjecting a patient to a open lung biopsy is a major advance in diagnostic bronchoscopy. Transbronchial lung biopsy (TBLB) (Fig. 10.6) is indicated when diffuse or localized interstitial, alveolar, miliary or fine nodular pattern of disease is evident radiologically, but the diagnosis cannot be established by a less invasive diagnostic technique. The common indications for TBLB include miliary tuberculosis, pneumoconiosis, sarcoidosis, rheumatoid lung, diffuse panbronchiolitis, diffuse interstitial pulmonary fibrosis, pulmonary infiltration with eosinophilia (PIE), leukemic infiltration, hypersensitivity pneumonitis, *Pneumocystis carinii* pneumonia (PCP), lymphangitic carcinomatosis, eosinophilic granuloma, viral infections and alveolar proteinosis. The only absolute contraindication is a non-cooperative patient. The relative contraindications to TBLB include untreated bleeding diatheses, severe pulmonary arterial hypertension and patient's inability to control cough.

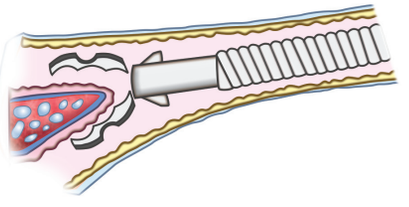

Fig. 10.6: Transbronchial lung biopsy

The tip of a fiberoptic bronchoscope (FOB) is wedged and the forceps inserted through the working channel into the target bronchus guided by fluoroscopy. The use of fluoroscopy during TBLB is debatable, but most bronchoscopists routinely use it. The forceps is carefully advanced, until it reaches the visceral pleura when slight resistance is felt. If during insertion, the patient complaints of chest pain, the forceps must be withdrawn 0.5 to 1 cm, immediately. The position of the forceps is monitored and the forceps is then withdrawn by about 3 cm. The forcep is opened and the patient is asked to inspire. After this, the patient is asked to expire slowly and simultaneously, the forceps is advanced towards the peripheral lung field, leaving 1 cm of lung beyond the forceps at the end of expiratory phase. At the same time, the forceps is pushed gently towards the peripheral lesion and is closed to obtain a biopsy specimen and withdrawn (Figs 10.7 to 10.10). The bronchoscope should not be removed from the wedge

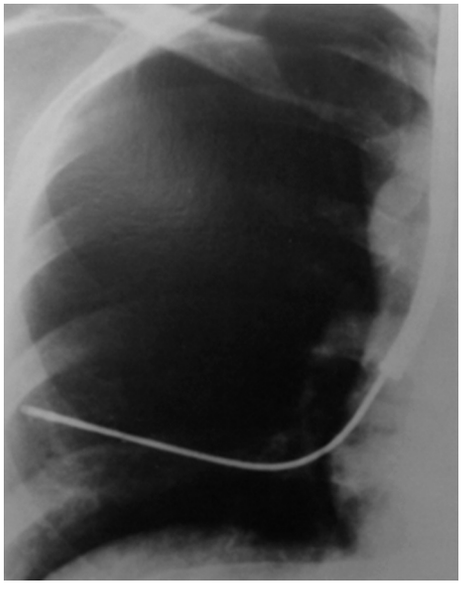

Fig. 10.7: Closed forceps tip is pushed through fiberoptic bronchoscope in peripheral part

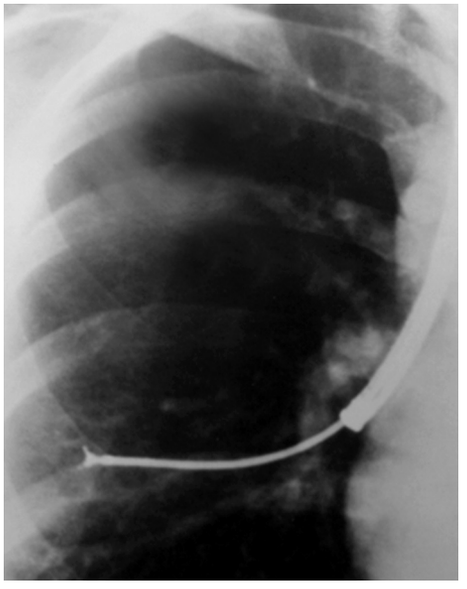

Fig. 10.8: Forceps tip is pulled back about 3 cm and opened

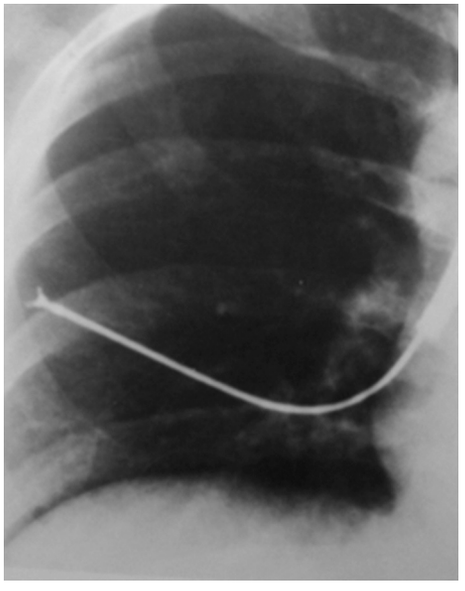

Fig. 10.9: The open forceps tip is positioned in peripheral part of the bronchus about 1 cm from visceral pleura

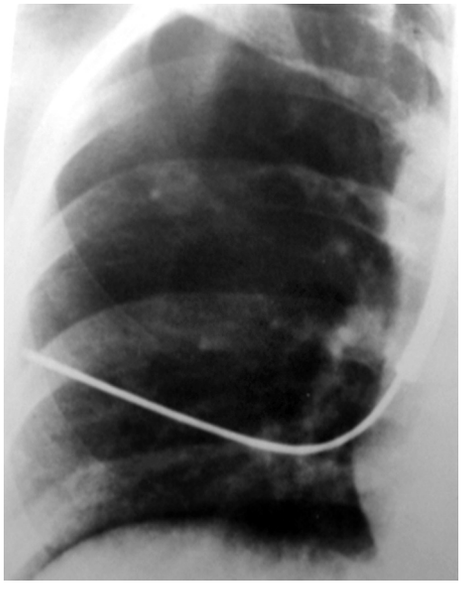

Fig. 10.10: The open forceps tip is closed and taken out

position, till it is ensured that no significant bleeding takes place. Many bronchoscopists routinely screen the lung at the end of the procedure. Screening should be routinely done, if there is chest pain during biopsy, the patient develops breathlessness or the patient had coughed excessively during the procedure. Controversy still exists to how many biopsy specimens are to be obtained. In diffuse disease, three adequate looking samples are probably sufficient for histology, although some work has shown an increase in positive histological yield with upto six biopsies.[2,11] If the lesion is localized, the dominant site is biopsied and if the lesion is diffuse, the preferrable sites are anterior basal, lateral basal, posterior basal segments of lower lobe and anterior segment of upper lobe. It should be emphasized that both lungs should not be biopsied simultaneously, because bilateral pneumothorax may occur.

Proper handling of specimen is crucial, if optimal information is to be obtained from the procedure. The tissue for routine histology is placed in 10 percent formalin solution and tissue for microbiological studies is usually sent in sterile saline. Tissue may be sent for frozen section, if facilities are available. Complications during TBLB include pneumothorax, which is the most common, occurring in less than 1 percent, if fluoroscopic guidance is used and may be raised up to 3.4 percent, if guidance is not used.[12,13] Moderate to severe bleeding occurs in 0.6% to 5.4% of cases.[14] Bleeding is almost always controllable. Other complications such as pneumomediastinum, septicemia, myocardial infarction, pneumonia, hypoxemia, right heart failure, exacerbation of bronchial asthma and respiratory arrest are very rare.

The diagnostic yield for a peripheral tumor has been found to be 61 percent under fluoroscopic guidance and 31 percent without guidance.[15] The diagnostic yield is influenced by the size of the lesion and is lower in lesions less than 2 cm in diameter. The diagnostic yield in infection varies between 47% and 91%.[16] Combined transbronchial biopsy and BAL has been claimed to have a yield of 90 percent in *Mycobacterium avium*-intracellulare (MAI) infected patients with acquired immune deficiency syndrome (AIDS).[17] The sensitivity of TBLB for *Pneumocystis carinii* infection is nearly 100 percent if combined with BAL.[17]

BIOPSY FROM PERIPHERAL MASS LESIONS

This procedure is used when mass lesions are not visible at fiberoptic bronchoscopy. First locate the mass lesion by chest radiography/CT scan .The bronchoscope is then inserted into the bronchus and under fluoroscopic guidance, the forceps is eased forward with utmost care through the channel of the bronchoscope to reach the mass lesion. If the forceps overlaps the tumor shadow in fluoroscopy and when it is sure under fluoroscopy that forceps has succesfully attached to the mass lesion, the forceps are opened and closed, while within the tumor and the biopsy specimen is extracted. In one of the studies by the author himself, who performed biopsy from endoscopically non-visible lung tumor without fluoroscopy guidance, which yielded diagnosis in 34 percent cases. Overall diagnostic yield was improved to 37 percent when biopsy was combined with bronchial aspirate and postbronchoscopy sputum smear cytology. Diagnostic yield further increased to 52 percent when the size of lesion was more than 2 cm in diameter, as compared to just 8 percent in lesions less than 2 cm in diameter. The diagnostic yield was maximum, reported in 61 percent cases when the lesions were situated between 2.5 to 5.0 cm from the hilum.[18]

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CHAPTER

11 Staging of Bronchogenic Carcinoma by Bronchoscopy

STAGING OF BRONCHOGENIC CARCINOMA

Since the development of the techniques of computed tomography (CT) scanning and transbronchial needle aspiration (TBNA), the staging of bronchogenic carcinoma has changed. In the past, bronchoscopy played a limited role in the staging of bronchogenic carcinoma and the major use of bronchoscopy was to assess the tumor (T) status. Development of the CT scan has expanded the role of the radiologist in the staging of bronchogenic carcinoma. Numerous reports have been published about the staging of lung cancer by CT scan, in particular, about its usefulness in evaluating the nodal status.[1–3] The general conclusion is that the CT scan, when used to evaluate the mediastinum, is very sensitive, but not too specific.

The value of flexible bronchoscopic techniques of TBNA in staging bronchogenic carcinoma has also been reported. In general, TBNA is sensitive and specific for the diagnosis of lymph node involvement.[3–5] The combined use of these two relatively new techniques, the CT scan and TBNA, has provided us with a great opportunity for non-invasive staging of bronchogenic carcinoma.

The major use of bronchoscopy is to assess the T (tumor) status. Lesions beyond the lobar bronchus were considered as T1, tumors involving the main bronchus, 2 cm or more distal to the carina, were considered as T2, tumors in the main bronchus within the 2 cm distance from the carina, but without involvement of the carina, were considered T3 and finally, tumors invading the carina were considered as T4.

The development of the TBNA technique has markedly expanded the role of bronchoscopy from diagnosis to staging. The noninvasive nature of this technique is most promising for the staging of bronchogenic carcinoma. The combined use of TBNA with the CT scan can have a major impact on the management of lung cancer, however, one major problem with TBNA is that it has not been used as widely as it should be, mainly because it is a relatively new procedure with unpredictable results.

Wang Classification

The sensitivity of TBNA could be improved with proper knowledge of anatomy and technique as described below by Wang.[3] When used together, CT scanning and bronchoscopy retain the sensitivity of the CT scan in discovering abnormal lymph nodes (LNs) and incorporate the specificity of TBNA to diagnose the cell type of a metastatic lesion in the lymph node.

The most commonly involved lymph nodes and airway branches, used as landmarks for TBNA, by Wang classification are included.[3] By following these landmarks, it is possible to sample even normal sized lymph node tissue from the mediastinum and hilar areas. Four bronchoscopic views or sections from the CT scan are used as key reference points (Fig. 11.1):

1. The lower trachea near the carina.
2. The right main bronchus near the right upper lobe orifice.
3. The bronchus intermedius near the middle lobe orifice.
4. The left main bronchus, near the lower or upper lobe spur.

Eleven nodal stations were named:

1. Anterior carina lymph node.

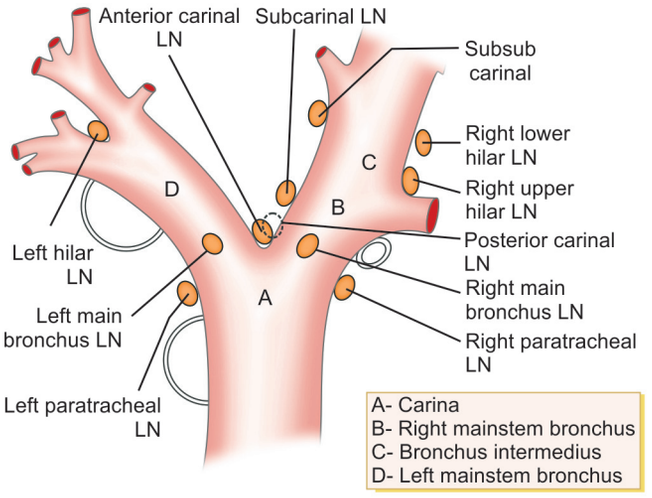

Fig. 11.1: Different bronchoscopic views from computerized tomography (CT) scan

2. Posterior carina lymph node.
3. Right paratracheal lymph node.
4. Left paratracheal lymph node (aortic pulmonary window).
5. Right main bronchus lymph node.
6. Left main bronchus lymph node.
7. Right upper hilar lymph node.
8. Subcarinal lymph node.
9. Right lower hilar lymph node.
10. Sub subcarinal lymph node.
11. Left hilar lymph node.

Carina

At the first level, from the lower end of the trachea, while viewing the carina and both main bronchi, six nodal stations can be identified:

1. Anterior carina.
2. Posterior carina.
3. Right paratracheal.
4. Left paratracheal.
5. Right main bronchus.
6. Left main bronchus.

Carinal lymph nodes are divided into anterior and posterior. At this level, the anterior carina is defined as the lymph node in front of and between the proximal end of the right and left main bronchi. The posterior carina is defined as behind and between the proximal portion of the right and left main bronchi or often directly behind the right main bronchus. The puncture of the anterior carina lymph node occasionally, results in bloody aspiration, but there are no other complications. In order to avoid puncturing the azygoesophageal recess and to avoid the possibility of causing pneumothorax, biopsy of the posterior carina lymph node should only be performed, when CT scanning demonstrates enlarged lymph nodes in that area.

Right Main Bronchus

In previous reports for TBNA staging, only right and left paratracheal and carina lymph nodes were emphasized. There is less mention of the main bronchus and the different levels of subcarinal or hilar sampling. As experience with the use of CT scanning to visualize the mediastinal and hilar lymph nodes grows, it becomes apparent that the lymph nodes in front of the right upper lobe spur and the subcarinal lymph nodes are quite commonly involved. The CT scanning at the level of the right upper lobe bronchus is chosen to identify the right upper hilar and subcarinal nodes (stations 7 and 8).

Bronchus Intermedius

At the bronchus intermedius, near the right middle lobe bronchus, lymph nodes are around the side of the bronchus intermedius. Occasionally, lymph nodes in front of the bronchus intermedius, which can push the pulmonary artery forward, are noticed. Those groups of lymph nodes are defined as group 9, lower right hilar nodes (station 9).

Left Main Bronchus

The final cut by CT scan is the level of the left upper lobe and left lower lobe spur, the lymph nodes between the upper lobe and lower lobe bronchus are defined as left hilar station 11 (station 11). The recommended puncture site is at the mid-lateral wall of the left lower lobe bronchus at the level of the superior segment orifice, in order to avoid the descending left pulmonary artery and to ensure a deep penetration of the needle into this group of lymph nodes.

The location of mediastinum and hilar LNs for TBNA, which are defined by CT scan in Wang TBNA staging system are explained in Table 11.1. The TBNA site for bronchoscopy and hilar LNs, which are defined by bronchoscopy in Wang TBNA staging system are explained in Table 11.2.

Table 11.1: Wang TBNA* staging system[3]: location of mediastinum and hilar lymph nodes for TBNA (defined by computerized tomography scan)

Sl. no.	Lymph node	Location
1.	Anterior carina	In front and between proximal portion of right and left main bronchi
2.	Posterior carina	Behind and between proximal portion of right and left main bronchi or directly behind right main bronchus
3.	Right paratracheal	Behind superior vena cava and in front of anterolateral aspect of lower trachea near the azygous arch
4.	Left paratracheal angulation (aortic pulmonary window)	Lateral to trachea, near tracheobronchial Below the aortic arch and above the left main pulmonary artery
5.	Right main bronchus	In front of right main bronchus
6.	Left main bronchus	In front of left main bronchus
7.	Right upper hilar	In front and between the right upper lobe bronchus and bronchus intermedius
8.	Subcarina	Between right and left main bronchi, at or near level of right upper lobe bronchus
9.	Right lower hilar	Lateral or in front of bronchus intermedius or at near level of right middle lobe bronchus
10.	Subsubcarina	Between bronchus intermedius and left main bronchus, at or near level of right middlelobe bronchus
11.	Left hilar	Between left upper lobe and left lower lobe bronchus

*TBNA: transbronchial needle aspiration.

Table 11.2: Wang TBNA* staging system[3]: TBNA site for mediastinum and hilar lymph nodes (defined by bronchoscopy)

Sl. no.	Lymph node	Site
1.	Anterior carina	First and second intercartilage interspace from lower trachea at about 12–1 o'clock position
2.	Posterior carina	Posterior portion of carina at about 5–6 o' clock position
3.	Right paratracheal	Second to fourth intercartilaginous interspace of lower trachea at about 1–2 o'clock position
4.	Left paratracheal (aortopulmonary window)	First or second intercartilaginous interspace from lower trachea at about 9 o'clock position
5.	Right main bronchus	First or second intercartilaginous interspace from proximal right main bronchus at about 12 o'clock position
6.	Left main bronchus	First or second intercartilaginous interspace from proximal left main bronchus at about 12 o'clock position
7.	Right upper hilar	Anterior portion of right upper lobe spur
8.	Subcarina	Medial wall of right main bronchus at about 9 o'clock position, proximal to level of right upper lobe orifice
9.	Right lower hilar	Lateral or anterior wall of bronchus intermedius at about 3 o'clock position and 12 o'clock position near or at level of right middle lobe orifice
10.	Subsubcarina	Medial wall of bronchus intermedius at about 9 o'clock position, proximal to level of right middle lobe orifice
11.	Left hilar	Lateral wall of left lower lobe bronchus at about 9 o'clock, at level of superior segment orifice of left lower lobe

*TBNA: transbronchial needle aspiration.

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CHAPTER

12 Complications

The morbidity and mortality associated with flexible bronchoscopy and its associated procedures are low. Bronchoscopists should be familiar with factors known to increase a patient's risk for bronchoscopy, as well as the type of complications that can occur and their management. The goal of bronchoscopist should be to provide a safe procedure, free of complications in an efficient manner with minimal discomfort to the patient.

The incidence of minor complications is 0.2 percent, major complications 0.08 percent and mortality 0.01 percent. Minor complications include vasovagal reactions, fever, cardiac arrhythmias, bleeding, obstruction of the airways, nausea and vomiting, pneumothorax, psychotic reactions and aphonia. Major complications are defined as those, which by their nature are serious or require specific resuscitative measures. Major complications include respiratory arrest, pneumonia, pneumothorax and airway obstruction. Approximately, half of the life-threatening complications are associated with premedication or topical anesthesia. One can address several areas from which complications of flexible bronchoscopy arise.[1]

PREMEDICATION

Excessive premedication can result in serious episodes of respiratory depression. Other complications are transient hypotension and syncope. Pretreatment with an anticholinergic and performance of the procedure in the supine position, should help offset this complication. Hyperexcitable state can be a problem for patients, who become agitated and develop a state of panic.

LOCAL ANESTHESIA

Excessive local anesthesia can cause respiratory arrest, seizures, methemoglobinemia and death. Xylocaine has a wider margin of safety than tetracaine. Laryngospasm with airway obstruction, associated with tonic contraction of the laryngeal and pharyngeal structures, may occur with application of a local anesthetic or manipulation of the vocal cords and adjacent structures. Minor cases may be treated with oxygenation. Stubborn cases may require ventilation by positive airway pressure with 100 percent oxygen. Intravenous sedation and small doses of a drug such as succinylcholine may be necessary, if these measures are not successful.

HYPOXIA

Any instrument introduced into the respiratory tract will cause airflow obstruction, increase airway resistance and thereby, affect respiratory gas exchange. The resting partial pressure of oxygen (PaO_2) has shown to drop by an average of 2.5 kPa (20 mm Hg) during fiberoptic bronchoscopy and fall in PaO2 increases with the duration of the procedure and last up to 4 hours after bronchoscopy. Hypoxia has been well recognized as one of the complications of bronchoscopy[2, 3] and is known to occur frequently.[4] With the newer flexible bronchoscopes having large suction channels and the procedure being performed in more critically ill patient, the potential for hypoxia is even greater. This complication is more frequently appreciated now, as pulse oximetry is readily

available. The more severely ill the patients, the more likely that hypoxia will occur and the more severe the hypoxia is likely to become. In acutely ill ventilated patients, one study documented, an average decline in the PaO_2 of 26 percent, at the end of the procedure compared to baseline with a slight rise in partial pressure of carbon dioxide ($PaCO_2$). Hypoxia can also occur during bronchoalveolar lavage.

A mild, but significant reduction in the PaO_2 persisted for up to 2 hours after the procedure.[2] With proper attention to the patient's oxygenation, hypoxia should infrequently be a problem during bronchoscopy. Depending on the patient's baseline oximetry or arterial blood gas determination, oxygen supplementation may be as simple as the use of a nasal cannula, a close-fitting mask with a hole or diaphragm cut in it,[5] an open-face tent or an endotracheal tube with an adapter. In those patients, already receiving supplemental oxygen by one of these methods, an increase in the fraction of inspired oxygen (FIO_2) prior to starting the procedure, should be considered as long as carbon dioxide (CO_2) retention is not a problem. Also, attention should be given to maintaining an increase in FIO_2 for an adequate time, following the patient's procedure to assure return to the baseline arterial oxygen tension. Supplementary oxygen should be continued for at least 2 hours after the procedure, in those patients previously known to be hypoxic.

HYPERCARBIA

The flexible bronchoscope takes up space in the airway and resistance to breathing is increased. An adult patient with adequate respiratory reserve can easily compensate for a mild increase in resistance to breathing by normal respiratory mechanisms. Significant hypercarbia with respiratory acidosis is rare, but can occur in patients who develop acute severe bronchospasm or in those marginal patients, whose respiratory reserve is minimal. In patients with high alveolar-arterial oxygen gradients, despite oxygen supplementation and CO_2 retention, placement of an endotracheal tube with a balloon cuff over the bronchoscope should be considered. Careful observation following the procedure prior to extubation is important, particularly when sedation is used.

BRONCHOSPASM

Bronchospasm as a complication of bronchoscopy can be severe and potentially life threatening,[6] especially in those patients with unrecognized bronchial hyperreactivity. Patients with asthma undergoing bronchoscopy, should be on optimal treatment. Bronchodilators have been shown to reduce the decrease in forced expiratory volume in 1 second (FEV_1) with bronchoscopy and should greatly reduce the chance of severe bronchospasm occurring.[7] Large doses of atropine (1–2 mg) administered parenterally or by inhalation, may be helpful in reducing the bronchoconstrictive effects of bronchoscopy.[8] The intravenous line would provide a quick access for the administration of a corticosteroid should it be desired. Having available facilities for intubation and respiratory support is imperative. The risks and potential benefits of bronchoscopy must be constantly assessed in those patients with bronchial hyperreactivity. If such patients are adequately pretreated with proper medication, the after effects of bronchoscopy can be greatly reduced.

HEMODYNAMIC EFFECTS OF BRONCHOSCOPY

Bronchoscopy induces significant hemodynamic changes that are maximal during passage through the larynx and during suctioning. The mean arterial pressure can increase by 30 percent, heart rate by 43 percent, cardiac index by 28 percent and mean pulmonary arterial occlusion pressure by 26 percent compared with prebronchoscopic control values.[9] The changes are of little consequence in patients with normal cardiovascular function and blood supply. With potential hypoxemia due to flexible bronchoscopy, an increased risk for myocardial infarction and arrhythmias exist in such patients.

CARDIAC ARRHYTHMIAS

Arrhythmias have been noted with bronchoscopy and can lead to asystole and death.[10] Patients with coronary artery disease, have the potential to develop ischemia and thereby, an increased risk of development of serious cardiac arrhythmias. The most common arrhythmia is a sinus tachycardia and when all arrhythmias are combined, the incidence can approach 70% to 80%.[12] Lidocaine

topical anesthesia, may have a protective effect in terms of the incidence of cardiac arrhythmias. Atenolol has also been shown to reduce the number of cardiac arrhythmias, when used prior to bronchoscopy.[13] Electrocardiographic monitoring during bronchoscopy,[14] along with the routine use of oximetry can allow for early intervention to prevent the dangerous combination of hypoxia, myocardial ischemia and arrhythmias.

INFECTIOUS COMPLICATIONS

Fever can occur following bronchoscopy and 16 percent of patients developed fever in one study.[15] The exact cause of fever is uncertain. Bacteremia following bronchoscopy has been reported in isolated case reports, sometimes with serious consequences.[16] Serious bacteremic events, appear to be associated with Gram-negative organisms, particularly *Pseudomonas* and dangerous consequences can develop, despite prophylactic antimicrobial therapy.[17] Pneumonia has been reported following bronchoscopy. Lung abscesses have also occurred and have been reported complicating bronchoscopic lung biopsies.[18] The possibility of aspirating abscess cavity contents following bronchoscopy, has raised questions about the place of bronchoscopy in the evaluation and treatment of lung abscesses. Some measures that may be taken to minimize or prevent aspiration of the contents of a lung abscess include:

1. Minimal use of depressant drugs and local anesthetics in an effort to preserve to some degree the protective defences, such as gag and cough reflexes.
2. Positioning the patient in a lateral or head-down position, until all airway reflexes have returned, to help prevent aspiration of material to the unaffected side.
3. Careful intraoperative and postoperative observation for the development of sudden aspiration by personnel prepared to treat this complication reflexly.

Clearly, one should have adequate suction equipment available and be prepared to intubate the patient, if necessary. Multiple pseudo-outbreaks of bacterial, fungal and tuberculous infections have been reported due to contaminated bronchoscopes.[19] Transmission of *Mycobacterium tuberculosis* has been documented[20] and the human immunodeficiency virus (HIV) has been cultured from bronchoscopes used in infected patient. Thus, to prevent transmission of these infectious agents, meticulous care must be taken in cleaning of the bronchoscope between procedures.

OTHER COMPLICATIONS

Flexible bronchoscopy is a low-morbidity procedure, but it can be associated with unusual complications that in themselves may threaten the life of the patient. For example, cerebral air embolism complicating bronchoscopic lung biopsy is an uncommon complication.[21] With increasing use of the flexible instrument for foreign body removal, one must be aware of the potential risk of massive hemoptysis and be prepared to deal with it. Fatal hemorrhage has also occurred following flexible bronchoscopy on a patient with mycotic aneurysms of the pulmonary artery.[22] Bronchoscopy in intravenous drug abusers may lead to endocarditis, septic pulmonary emboli, mycotic aneurysms and massive hemoptysis.[22] Acute carcinoid syndrome has also been reported to occur during bronchoscopic biopsy of a solitary nodule in a 39-year-old woman.[23] Temporomandibular joint dislocation can occur following flexible bronchoscopy or gastroscopic examination infrequently. It is felt that it more often occurs following trauma, sudden wide-opening movements of the mouth, prolonged wide open mouth during dental procedures or extreme capsular laxity and chronic subluxation of the temporomandibular joint.[24] Age may be a contributing factor.

Bronchoscopists are asked to conduct a prior clinical checkup on patients with serious infections that can potentially affect personnel performing the examination. Since, it is impossible to identify these patients in all circumstances, the potential hazard to the bronchoscopist dictates that he or she be vigilant in protecting all individuals involved in the examination.[25] This requires gloves, appropriate protective attire, masks, close-fitting eye protection and extreme caution to avoid inadvertent injury by a contaminant needle. Adequate procedure room ventilation is essential to reduce the risk of airborne pathogens, infecting bronchoscopy personnel.

All complications, which occurs during bronchoscopy are mentioned in Box 12.1.

Box 12.1: Complications of bronchoscopy

Drugs
Premedication and intraoperative sedation
Respiratory depression, apnea, hypotension, syncope, hyperexcitable state, allergic reaction.
Local anesthesia
Respiratory arrest, seizures, methemoglobinemia, laryngospasm, bronchospasm, allergic reaction, nausea and vomiting.
Bronchoscopy and associated procedures
General
Laryngeal edema, hypoxia, hypercarbia, bronchospasm.
Cardiovascular
Atrial and ventricular arrhythmias, myocardial ischemia, angina, cardiac arrest.
Infections
Temperature elevation, bacteremia, pneumonia, metastatic infections, inoculation of infectious agent (bacterial, mycobacterial, fungal, viral including human immunodeficiency virus, intrabronchial contamination by abscess cavity content).
Therapeutic suctioning
Hypoxia, bleeding.
Bronchial brushing, bronchial biopsy, bronchoscopic lung biopsy
Hemorrhage, perforation of bronchus or lung, pneumothorax, breakage of the brush or forceps.
Bronchoscopic needle aspiration
Hemorrhage, perforation of the great vessels, hemomediastinum, pneumomediastinum, pneumothorax.
Endobronchial laser therapy
Hypoxia, hemorrhage, perforation of esophagus, bronchus or lung, pneumothorax, fire, death.
Bronchoalveolar lavage
Fever, pneumonitis, bronchial bleeding, bronchospasm, pneumothorax.
Foreign body removal
Massive hemoptysis, airway obstruction.

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CHAPTER

13 Bronchoscopy-induced Hemorrhage

Bronchoscopy-induced hemorrhage has been reported to vary from less than 1% to 20%.[1–8] Life-threatening bleeding is rare. If bronchoscopy is performed for the evaluation of hemoptysis, the risk of aggravating pre-existing hemorrhage is always present, however, such occurrences are also uncommon.

PREDISPOSING FACTORS

In general, neoplastic lesions of the tracheobronchial tree are more likely to bleed upon biopsy than benign mucosal lesions. Amongst the tumors, tracheobronchial carcinoid tumors are more vascular and tend to bleed more, but this is not a contraindication for biopsy. Also endobronchial tumors, which are necrotic, may expose newly developed vessels over the surface of the tumor and a brush or a biopsy forceps can easily traumatize the vessel and provoke significant bleeding.[4–7] Large cavitory lesions in the pulmonary parenchyma may also predispose to significant bleeding upon instrumentation.[8] This is more likely in patients with aspergilloma,[10–12] tuberculous cavities and cavitated cancers. Patients who present with hemoptysis due to severe bronchiectasis, may bleed more during or after bronchoscopy.

Transbronchial lung biopsy is more frequently, followed by significant hemorrhage compared to biopsy of endobronchial lesions.[5] Transbronchial lung biopsy-induced bleeding occurs in 3% to 5% of patients. Inadvertent laceration of pulmonary vessels accompanying the unguided bronchoscopic lung biopsy and the number of attempts at biopsy may contribute to the increased incidence of bleeding, occasionally it may be fatal. The risk of bleeding is not related to the type of biopsy forceps used. However, the larger the number of biopsies obtained, the higher the risk of bleeding.

In patients with tracheobronchial tumors, bleeding can occur following cytological brushing or forceps biopsy. Bronchoscopic brush or biopsy-induced bleeding is more likely in the presence of underlying coagulation disorders. In the absence of such disorders, it is difficult to predict, which patient is going to bleed. However, diagnostic bronchoalveolar lavage can be performed safely, even in patients with severe coagulopathies.[13,14] Bronchoscopic needle aspiration and biopsy may cause hematoma in the mediastinum, but seldom produce tracheobronchial bleeding. Significant bleeding (more than 100 mL) is a complication during yttrium-aluminum garnet (YAG) laser treatment of tracheobronchial tumors.[15] Therefore, it is preferable to perform this procedure using rigid bronchoscope. Rarely, some of the patients may bleed following photodynamic therapy and brachytherapy.

One study[5] interpreted the experience with 6,969 flexible bronchoscopies and 3,096 bronchoscopically guided biopsies, performed over a 9-year period and reported clinically significant bleeding (more than 100 mL) in 0.83 percent of flexible bronchoscopy and 1.9 percent of bronchoscopic lung biopsies. A variety of underlying, coexisting non-pulmonary illessness were present in 24 percent of cases with significant bleeding. These factors included metastatic carcinoma, renal dysfunction and immunosuppression. Earlier studies reported the rate of clinically significant bleeding in 15% to 26% of procedures, performed in immunosuppressed patients.[8]

TREATMENT OF BRONCHOSCOPY-INDUCED HEMORRHAGE

Insignificant or non-life-threatening bronchoscopy induced bleeding may not require aggressive therapy. The step-by-step approach to the various techniques and treatments to control significant hemorrhage in the tracheobronchial tree is listed below.

General Measures

Maintaining airway free of blood is an important initial step. The life-threatening factor is not the loss of blood, but the danger of asphyxiation from blood and blood clots obstructing the airways. The easiest procedure is to position the patient in the supine, head-down position with the bleeding side in the dependent position. Oxygen should be given, preferably with continuous monitoring of oxygen saturation with pulse oximetry. An intravenous access must be secured.

Definitive Therapy

The cardinal rule for controlling hemorrhage occurring during a bronchoscopy is not to withdraw the bronchoscope.[16] If the bronchoscope is withdrawn and bleeding is extensive, proper position of the instrument for control may never be recovered.

Bronchoscopic Suction

Significant bleeding in the trachea or proximal bronchial tree requires continuous bronchoscopic suction, which prevents formation of clots in the airways and spilling of blood to distal airways. The latter effect is an important step to prevent excessive coughing by the patient. Repeated contact of the bleeding lesion by the bronchoscope should be avoided as much as possible. If the bleeding is arising from a very focal site, the bronchoscope itself can be used to laterally compress the lesion, if the lesion is in the trachea or mainstem bronchi. If continuous suctioning fails to control the bleeding, other measures may have to be considered. If bleeding slows down and a clot begins to form in a segmental or even a lobar bronchus, it is prudent to allow the clot to fully form, instead of suctioning and precipitating further hemorrhage.

Iced Saline Lavage

One of the easier techniques to slow the rate of bleeding and to stop it is to instill ice-cold saline through the bronchoscope.[17] The bronchoscopist should make sure that excessive saline is not used and that most of the saline is recovered by suction after each instillation. The saline can be used for control of bleeding from the proximal bronchial tree, as well as hemorrhage caused by bronchoscopic lung biopsy.

Vasoactive Drugs

Vasoactive drugs can be administered systemically or locally.[18] The most common used vasoactive agent is epinephrine (1 : 20,000). To prepare this, epinephrine 1.0 mL (1 : 1,000), is mixed thoroughly with 19 mL normal saline. If the bleeding is mild, epinephrine (1 : 20,000 up to 3 mL) can be instilled through the working channel of the flexible instrument. Usually, a paling of the mucosa around the tumor indicates the vasoconstrictor effect on the supplying vessels. Serious effects of these agents on the systemic circulation, heart rate or bronchomotor tone is minimal or negligible.

Bronchoscopic Tamponade

If the bleeding is arising from a distal area, the tip of the bronchoscope should be wedged into the bronchus, leading to the bleeding site and continuous suction applied. This wedge technique is effective in controlling the bleeding, following bronchoscopic lung biopsy or biopsy or manipulation of a lesion in the distal bronchial tree. The continuous bronchoscopic suctioning causes the distal bronchus to collapse, stopping the bleeding by compression.

Balloon Tamponade

Balloon catheters can be used for selectively blocking a lobe or a segment.[19,20] Inserted via the working channel of a flexible bronchoscope or through a rigid instrument, the balloon blocks only the bleeding bronchus. Several types of catheters are available. Balloon catheters have certain limitations and inherent problems. They are well suited for use in patients, whose rate of bleeding is slow and the location is at a segmental level or beyond. Bleeding at the origin of lobar bronchi is difficult to control with balloon tamponade. Insertion of the balloon into the upper lobe bronchi is more difficult, because the tendency of the

catheter stem to straighten and slip out of the upper lobe bronchi. Excessive coughing by the patient can dislodge the balloon. In patients who present with continuous bleeding, the presence of the catheter in the working channel of the flexible bronchoscope prevents the suctioning of blood. It also interferes with the bronchoscopic visualization of the tracheobronchial tree.

Fibrin Glue

Topical thrombin alone, 5 to 10 mL (1,000 units/mL) or fibrinogen 2 percent, 5 to 10 mL followed by thrombin 5 to 10 mL, can be infused directly through the channel of the flexible bronchoscope.[21] The bronchoscope is retained in place for about 5 min after which gentle suction is applied to confirm hemostasis. Persistent and significant bleeding tends to flush away the fibrin glue, before a stable clot can form.

Isolation of Bronchial Tree

In patients with serious bleeding arising from one side, the danger of flooding the nonbleeding side and causing asphyxia is significant. Isolation of the nonbleeding side is an important consideration in such situations. The rigid bronchoscope is useful in achieving this. The instrument is introduced into the nonbleeding bronchus, so as to block the blood from spilling into the healthy side and to maintain sufficient ventilation. The most effective method, however, is the intubation with a double-lumen tube. The disadvantage is that the double-lumen endotracheal tubes block an entire lung, even if the bleeding is segmental or subsegmental.

Laser Coagulation

If the bleeding from a bronchoscopically visible lesion does not stop spontaneously, coagulation therapy may be necessary. Smaller lesions can be coagulated with the laser. Lower energy (approximately 15 W) is suitable for coagulation. However, it is sometimes impossible to see the blood vessel supplying the lesion. Even, to distinguish between tumor and blood clot can be difficult.

Electrocautery

An alternative to laser coagulation is the electrocautery,[22] especially in combination with the rigid bronchoscope. As soon as the heavy bleeding stops, final coagulation with the neodymium (Nd): YAG laser should be done, as this technique has a higher and more reliable depth of penetration. However, the major disadvantage of cauterizing via the bronchoscope is the fact that the coagulation effect stops completely, if carbonized tissue covers the surface of the electrode. Repetitive cleaning of the electrode is required, making it a time-consuming procedure in a situation, where there is no time.

PREVENTION OF BRONCHOSCOPY-INDUCED HEMORRHAGE

Even though spontaneous cessation of bleeding is the rule in almost all cases of bronchoscopy-induced hemorrhage,[5] the bronchoscopist should be aware of the risks of bronchoscopy-induced bleeding and be prepared to manage it accordingly. The risk of bleeding should not deter the bronchoscopist from performing the appropriate procedure. During the preparation of the patient for the procedure, the bronchoscopist must ascertain underlying risk factors for bleeding. The presence of a clearly documented hemorrhagic diathesis is a contraindication to aggressive instrumentation such as brushing, biopsy of endobronchial lesions and transbronchial lung biopsy. Platelet counts of at least 50,000/mm^3 for endobronchial biopsy and 75,000/mm^3 for transbronchial lung biopsy have been recommended.[5]

Uremia is associated with a clinical bleeding tendency that can be quite severe, because platelet dysfunction is common in patients with renal failure. A 45 percent incidence of hemorrhage following bronchoscopic lung biopsy has been documented in uremic patients and a blood urea nitrogen of greater than 45 mg/dL is considered a relative contraindication to bronchoscopic lung biopsy.[8,23] Some bronchoscopists routinely assess coagulation parameters, as well as platelet counts in all patients undergoing flexible bronchoscopy and bronchial biopsy.[5] This routine practice may be unnecessary.[14] Prebronchoscopy coagulation screening should be obtained in patients with active bleeding, known or clinically suspected bleeding disorders, liver disease, renal dysfunction, malabsorption, malnutrition or other conditions associated with acquired coagulopathies.[24,25] Patients with platelet counts less than 50,000/mm^3 should receive six to ten packs of platelet transfusion before transbronchial lung biopsy.[3] Immunosuppressed patients with bone marrow failure frequently, require fresh-frozen plasma and platelets. In anticipation of bleeding,

the bronchoscopist should have at her or his disposal vasoactive agents, rigid bronchoscopy equipment and other instruments, as well as a well-prepared team.

Excessive suctioning following brush or biopsy can aggravate the bleeding. Brush or biopsy of bronchoscopically visible lesion is followed by immediate oozing of blood. Unless the bleeding is profuse, immediate suctioning close to just biopsied area is not necessary. In most situations, reflex vasoconstriction curtails bleeding and only minimum suctioning is required. Also, manipulation of the abnormal area by the bronchoscope or accessories should be avoided.

In patients with diffuse lung disease, some prefer biopsy of gravity-dependent portion of lung.[5] This is to prevent spill over of blood following biopsy from nondependent areas to dependent regions. To perform transbronchial lung biopsy, the tip of the flexible bronchoscope is wedged into the bronchus leading to the area to be biopsied and following biopsy, the instrument is maintained in the wedged position without suctioning in between the biopsies, until the desired number of biopsies are obtained. Approximately, 2 to 3 minutes after the completion of the biopsy procedure, the bronchoscopy is gently withdrawn, without suctioning and the blood is allowed to form a clot in the bronchus. If excessive bleeding occurs, continous suctioning is applied, so as to prevent aspiration of blood into other segments.

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CHAPTER

14 Pediatric Bronchoscopy

It was not until 1978 that the first reports of flexible fiberoptic bronchoscopy (FOB) in infants and young children appeared.[1] About 13% to 20% of adult pulmonologists perform bronchoscopy in pediatric patients despite having limited exposure to pediatric bronchoscopy during their training.[2,3] The number of pediatric pulmonologists are still insufficent to satisfy projected needs[4] and because infants, children, adolescents and young adults can present with a range of complex respiratory disorders, the adult pulmonologist may be the only person capable of adequately evaluating and performing bronchoscopy in this cohort of patients.[5] The expertise for pediatric bronchoscopy is only in hands of few individuals. Apart from adult pulmonologist, pediatric bronchoscopy services are also provided by pediatric pulmonologist ear, nose and throat (ENT) surgeons, thoracic surgeons and pediatric surgeons.

The comfort or discomfort felt by adult pulmonologists with pediatric patients should not be based solely on the age of the patient, but also on how comfortable they are with diseases, physiology and anatomy of younger patients, the physiological stage of the patient and the indication for bronchoscopy.

Bronchoscopy in pediatric patients has many similarities to those performed in adult patients. Driving the bronchoscopy is the same except for the smaller field of view, the shorter distances traversed and less distal reach. The bronchoscopy equipment is smaller and the light fibers are more easily broken, a working channel may not be present and the viewing image is smaller. Therefore, less of the anatomy is visible at any given time. Further, because dynamic airway collapse occurs more often in pediatric patients, the viewing area is often in motion and a videotaping of the procedure is often required, before a specific diagnosis can be made.

Specimens from brushings or bronchoalveolar lavage (BAL) are of smaller volume and hospital laboratories need to be organized to process these smaller samples. The total procedure time may be shorter, when compared to adult procedures. In the infants, in whom the bronchoscope may be only marginally smaller than the airway, procedures can be done in several repeated insertions each of no longer than 30 to 40 seconds with recovery.[6,7]

ANATOMICAL CONSIDERATIONS

A basic understanding of the age related differences between the adult and pediatric anatomy can help the bronchoscopist better anticipate equipments and procedure needs. The first major difference is the shape and position of the epiglottis. In the newborn and young child the epiglottis is elongated, more rounded and appears much shorter than in adults. The epiglottis can prove difficult to navigate in children, when attempting to enter the larynx with the bronchoscope. The larynx is itself placed higher up than in adults. Further, whereas the glottis is the most narrow portion of the adult airway, the subglottic space or that portion within the cricoid ring is the most narrowed in young children and infants. Therefore, the selection of the bronchoscope or the endotracheal tube for infants and young children must take into account the area under vocal cords is the area of limitation, not the space between vocal cords as in adult.[8]

The bronchial tree of the infant and young child are a miniature of the adult.[1] As a result of higher ratio of mucous glands and decreased mucociliary clearance, increased

secretions relative to an adult may be encountered, at bronchoscopy. The immature airways are more collapsible than adults and such collapse is often localized to anatomic sites (laryngomalacia, tracheomalacia and bronchomalacia).

Pediatric bronchoscopes are arbitrarily defined as those scopes with outside diameter of less than 5.5 mm. Adult scopes because of their larger diameter (6 mm or greater) are not indicated in children aged 10 years or younger.[7] Obviously, any pediatric scope can be used in larger or older patients. Later, models of pediatric bronchoscope have had essentially the same physical characteristics (diameter 3.2 mm, suction channel size 1.2 mm), as the original type. Smaller ultra thin instruments (diameter 2.2 mm) with no suction channel with controlled flexion, at the tip have also become available.[9,10]

Indications

Indications for flexible bronchoscopy in neonatal infants and pediatric age group includes the following:[11-16]

Diagnostic

1. Stridor.
2. Persistent atelectasis, pneumonia, bronchiectasis.
3. Unresponsive or localized wheezing.
4. Recurrent or persistent infiltrates.
5. Lung lesions of unknown etiology.
6. Chronic cough.
7. Hemoptysis.
8. Assessment of position, patency or airway damage related to endotracheal or tracheostomy tube.
9. Assessment of injury from toxic inhalation or aspiration.
10. Sampling from lower airway secretions and/or cells.
11. Obstructive emphysema.
12. Suspicion of endobronchial mass lesions.
13. Diagnosis of congenital anomalies of airways, lung.

Therapeutic

1. Removal of mucus plug.
2. Removal of bronchial cast.
3. Removal of foreign body.
4. Removal of granulation tissue.
5. Drug instillation.
6. Difficult intubation.
7. Hemoptysis.
8. Stenting of collapsing airways.
9. Lasers to relieve stenosis of airways.

Research

1. Selective bronchogram.
2. Laser therapy.
3. Low frequency ventilation.
4. Regional lung functional studies.

Contraindications

There is no absolute contraindication to flexible fiberoptic bronchoscopy in pediatric age group. The relative contraindications for pediatric bronchoscopy are:

1. Severe airway obstruction.
2. Pulmonary hypertension.
3. Severe coagulopathies.
4. Profound hypoxemia.
5. Unstable hemodynamics.

Complications

The incidence of serious complication in pediatric bronchoscopy is small.[16] They include:

1. Nasal bleeding.
2. Transient hoarseness of voice.
3. Discomfort in throat.
4. Glottic edema.
5. Bronchospasm.
6. Hypoxemia.
7. Hypercarbia.
8. Benign arrhythmias.
9. Hemoptysis.
10. Pneumothorax.
11. Transient bradycardia.

These complications can be minimized by careful execution of the procedure.

Procedure

The procedure should be described to the child and parents using positive reassuring words, to alleviate anxiety of both the child and parents. Some form of sedation is generally recommended. In almost all children an intravenous access should be established to administer sedatives (midazolam

0.005–0.1 mg/kg and meperidine 0.5–2.0 mg/kg) when required. These drugs are given in fractional doses with careful and continuous monitoring. Occasionally a child may fail to respond to the above and may be induced with a small dose of ultrashort acting barbiturate. This will produce light general anesthesia for 60 to 90 seconds.

Children are further prepared for flexible bronchoscopy by ensuring that their stomach is empty. Older children are kept fasting for atleast 4 hours, while younger children are allowed to have clear liquids untill 2 hours. Longer fasting period of 4 to 6 hours is required (if general anesthesia is to be used). In children younger than 4 years, it is advisable to pass a suction catheter through, the nose into the stomach before beginning the bronchoscopy.

Topical anesthesia is accomplished by direct instillation of 0.3 mL to 1 mL of 2 percent lignocaine into the nostril followed by direct instillation of 1 mL to 2 mL of 2 percent lignocaine to the larynx and subglottic space, directly through the bronchoscope. If further topical anesthesia is necessary in the lower airways, 1 percent lignocaine is used.

A 3.2 mm flexible bronchoscope is used in children of virtually any age and size. Ventilation may be maintained, either using a venturi technique or by the use of a ventilating side arm on the bronchoscope. List of calculated medications doses based on the weight of the patients should be available. Two suction setups should be simultaneously maintained, one for use through bronchoscope and one for control and care of oral secretions. Careful monitoring is necessary to ensure that the child continues, to ventilate and oxygenate well. Alternatively ultra thin bronchoscopes can be used. Infants, as small as 540 g have been found to ventilate satisfactorily around this instrument. In virtually, every other aspect flexible bronchoscopies in children are conducted in the same way as in adults.

Use of Pediatric Bronchoscopes in Adults

Because their length is same as that of adult bronchoscopes (550 mm), the smallest pediatric instruments allow entry into additional, 3 to 5 distal bronchial generations with good visualization. They may be also used for the evaluation, of cryptogenic hemoptysis and chronic cough in which the airway examination is negative, with an adult bronchoscope, repeating the examination with a pediatric bronchoscope may increase the diagnostic yield. The smaller bronchoscope may allow entry and examination into the regions, the larger bronchoscope cannot safely traverse such as through area of airway stenosis or narrowing. One other use is when entry via nasal route is desired and partial obstruction and narrowing of anatomy prevents safe passage of the large bronchoscope.

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CHAPTER

15 Advances in Fiberoptic Bronchoscopy

USE OF LASER IN BRONCHOSCOPY

The word laser is an acronym for "light amplification of stimulated emission of radiation". The development of lasers with different wavelengths and in particular of neodymium-doped crystal lasers, has permitted transmission of the beam through fiberoptic systems.[1] Lasers produce a beam of monochromatic, coherent light that can induce tissue vaporization, coagulation, hemostasis and necrosis. The neodymium: yttrium-aluminum garnet (YAG) (Nd-YAG) laser has a wavelength of 1,064 nm, which is in the near infrared spectrum. Its high scattering coefficient in soft tissue allows it to penetrate deeply (3–5 mm). It also has a strong thermal characteristic that can be used to coagulate blood vessels and other viable tissues, when placed at a distance from the target. Using a contact technique with specially designed sculpted or sapphire tips, the Nd-YAG laser can be used bronchoscopically to coagulate bleeding sources and to prepare a tumor before mechanical debulking.[2] Many reports have documented the beneficial effects of endobronchial Nd-YAG laser therapy, particularly in patients whose large airways are obstructed by primary thoracic or metastatic malignant tumors.[3,4]

The main indications for laser bronchoscopy are malignant tumors and tracheal stenosis.[5] Other indications are endobronchial granulomas, carcinoid tumors, hemorrhage, tuberculosis, bronchial fistula, suture thread removal, vascular dilatations, Wegener's granulomatosis, inflammatory pseudotumors, tracheopathia osteoplastica, foreign body removal amyloidosis and benign tumors such as hamartomas. The use of laser in tracheobronchial tree requires careful consideration of the anatomic location and configuration of the lesion. If the lesion is in close proximity to the esophagus or pulmonary artery, endobronchial laser therapy poses risk of fistula formation. The main complications of endoscopic laser resection are cardiac arrhythmias, hypoxia, hemorrhage, airway perforation, transient pneumothorax, mediastinal emphysema, cardiac arrest, myocardial infarction, embolism and fire.[6] Laser is preferably performed using a rigid bronchoscope under general anesthesia, but can be done using a fiberoptic bronchoscope. Nd:YAG laser photocoagulation therapy demonstrated a single-modality recanalization rate of greater than 90 percent for endobronchial obstruction of large central airways, but it is less successful with peripheral lesions or with associated extrinsic airway compression.

ENDOBRONCHIAL ELECTROCAUTERY

Endobronchial electrocautery is the application of heat produced by electrical current via the bronchoscope to treat tumor tissue using a probe or a snare. Electrocautery is an alternative treatment technique for immediate debulking of intraluminal tumor and has a curative potential in patients with radiologically occult cancer. Electrocautery can be applied either using a rigid or a flexible applicator specially designed for this purpose.[7] The most popular technique is the contact mode in which the probe is in direct contact with tissue. The choice of technique and instruments, whether rigid or flexible, under general or local anesthesia, depends upon the expertise of the bronchoscopist and the risk assessment. The degree of tissue destruction depends upon the power used, duration of contact, the surface area of contact, the density and moisture of tissue.

An insulating fiberoptic bronchoscope theoretically is safer in preventing 'current' leak, allows a better control of the process of coagulation and avoids burns or electrical shock to both the patient and the bronchoscopist.[3] The tumor area should be kept free of blood or mucus by continuous suctioning. Complications of electrocautery for endobronchial lesions can be hemorrhage, respiratory failure, pneumonia, fire/explosion and fibrosis. The estimated incidence of clinically significant bleeding in patients treated with electrocautery is 2.5 percent. The advantages are that the results are immediate, when using electrocautery in combination with mechanical tumor removal, simple, cost-effective for both benign and low-grade malignant lesions.

ARGON PLASMA COAGULATION

A relatively new development is the noncontact mode of argon beam coagulation or argon plasma coagulation (APC) in obtaining superficial homogenous tissue coagulation. This may be attractive for the treatment of superficial spreading tumors, for quick hemostasis, for recurrent respiratory papillomatosis and for obstructive bronchogenic carcinomas.[8,9] Histological studies have shown coagulative necrosis to be similar, either using standard electrocautery or the APC method, but APC causes more acute superficial tissue destruction and is more effective in the management of hemoptysis. This superficial action makes APC as a very safe tool. APC is less efficient than standard electrocautery or laser resection for indepth tissue destruction of bulky tumor.

CRYOTHERAPY FOR ENDOBRONCHIAL LESIONS

Cryotherapy works on the principle of cytotoxic effect by freezing the tissue. Through the channel probe, liquid nitrous oxide or liquid nitrogen is introudced, resulting in rapid creation of an 'ice ball' at the end of the tip. This freezing effect is maintained for about 20, the area is rewarmed, resulting in thawing. The indications for cryotherapy are similar to endobronchial laser or electrocautery. The purpose of cryotherapy is essentially, to ablate the endobronchial tumor. The advantages with cryotherapy is safety not only for the operator, but also for the patient and its cost-effectiveness. Cryotherapy has also been shown to have beneficial effects in conjunction with radiation therapy, as well as chemotherapy. Cryotherapy may be superior to lasers for distal lesions, because of lower risk of airway perforation. But, cryotherapy cannot be used to achieve rapid relief of symptomatic airway obstruction and it is not effective in paucicellular lesions that are relatively impervious to freezing, such as fibrotic stenosis, cartilaginous or bony lesions or lipomas. The two cryogens available to the pulmonologist are liquid nitrogen and nitrous oxide. The core temperature needed for a lesion to be destroyed is between –20°C to –40°C, which causes more than 90 percent of cell death. Nitrous oxide is the commonest cooling agent used in tracheobronchial cryotherapy. Cryotherapy is associated with greater difficulties in control and depth of penetration.[10,11] The monitoring of the extent of freezing remains a problem and there is no ideal solution. The only method of monitoring freezing using an endoscope is the bioelectric method. The most common serious complication is hemorrhage, others include edematous reaction, trauma.

ENDOBRONCHIAL BRACHYTHERAPY

Brachytherapy refers to the placement of a highly radioactive source inside a tumor mass. This technique ensures the delivery of a maximal therapeutic dose of radiation, to the tumor with a minimal effect on normal surrounding tissues. This can be done either by directly introducing the source into the tumor, via the natural route (endoluminal brachytherapy) or by placing the source into the tumor bed during tumor resection.[12] Indications include, occult carcinoma *in situ* or small invasive endobronchial lesions, which are discovered incidentally at bronchoscopy due to early irritative symptoms, like cough or hemoptysis. Relief of airway obstruction is the primary goal of endobronchial brachytherapy, although curative treatment may be attempted in conjunction with external beam radiation in selected patients. Brachytherapy is safest and most effective for central airway lesions. High-dose rate (HDR) brachytherapy (iridium-192), either alone or as a boost to external beam radiotherapy offers an excellent treatment option with good results, low morbidity, low cost and little inconvenience to the patient. It can also be used with the intention of cure for stage II, III b (T_3-T_4 N_0-N_3)[13] and as a palliative measure for stage IV tumor recurrence. Complications include hemoptysis, which may be fatal postradiation bronchitis and stenosis of airways. Symptomatic improvement can be achieved in 70% to

80% of patients and sometimes small tumors can be even cured by HDR brachytherapy.

Serious complications of brachytherapy include massive hemoptysis and fistula formation. Because of the risk of fatal hemorrhage, every effort should be made to rule out involvement of central vessels before treatment is administered.

PHOTODYNAMIC THERAPY

Photodynamic therapy (PDT) involves the administration of a tumor localizing photosensitizing agent, followed by activation of the agent by light of a specific wavelength.[14] This interaction cause selective death of tumor cells, by vascular shutdown resulting in hypoxia and secondary tumor necrosis. The mechanism of action involves the activation of a photosensitive molecule with the subsequent creation of a variety of active forms of oxygen, causing peroxidative reactions leading to cell damage and cell death. Various kinds of lasers besides argon-dye laser that have been used so far are, gold vapor laser, copper dye laser, excimer dye laser, diode laser and YAG laser.[15] The photosensitizers used are porfimer sodium (Photofrin) and benzoporphyrin derivatives. Indications include, relief of neoplastic endobronchial obstruction, delay of the tumor progression and improvement of symptoms making inoperable patients operable in selected cases.[16,17]

Complication of PDT are dyspnea, worsening obstruction due to mucus plugs, edema, atelectasis, fever, infections, hemoptysis, photosensitization and allergic or toxic reactions to photosensitizers. Contra-indications for PDT are tracheal lesions, carinal lesions, pneumonectomized patients, erosions or invasions of vascular structures and porphyrin hypersensitivity.

TRACHEOBRONCHIAL STENTING

In conditions of tracheobronchial obstruction, where surgical resection would not be feasible, stenting can be as an excellent palliative measure to maintain the patency of obstructed airways. The first stenting dates almost 50 years back, when William Montgomery[18,19] designed a silicone rubber T-tube for the management of subglottic and tracheal stenosis. Due to ill effects of a permanent tracheostomy orifice that accompanied the procedure, several innovative modifications were devised as time passed resulting in products, which were both easier to insert and well tolerated. Based on the foundation material several types of stents are available, which include polymer, metallic, covered metallic, hybrid stents. More recently, however, stents made of silicone or special alloys, such as nitinol (a nickel-titanium alloy with shape and size memory capacity that allow self-expansion on deployment), have had good results.[20,21] However, the response of the body tissue and outcome of the procedure depends more on biomechanical properties of the prosthesis, rather than the type of material used for construction. The number of stents used can be single or multiple. Stents are introduced using a specially designed stent introducer system (syringe plunger system) through the rigid bronchoscope. Newer stents can also be placed through a flexible catheter under fluoroscopic guidance or direct visualization.[22] Dilatation of the lumen helps in easier placement of the stent, which can be assisted by laser resection, balloon or bougies with care taken, not to rupture the tracheobronchial walls.[23]

Indications of stenting would include reestablishment of the patency of compressed or strictured central airways, support of weakened cartilages in tracheobronchial malacia and sealing off, of fistulas and dehiscence to the esophagus and pleural cavity. The complications are indicated by an increase or appearance of new onset cough, sputum production or dyspnea. These include misfire of the stent, stent migration, stent fracture, recurrence of obstruction, pent-up secretions, perforation of tracheobronchial walls, excessive granulation tissue formation[24] and hemoptysis. An ideal stent has not yet been developed. A bronchoscopist with extensive training, precise knowledge and experience regarding stent placement, rigid bronchoscopy and interventional techniques, such as laser or electrocautery would be a prerequisite for success. In spite of the advances made, the enigma remains as to the duration, a stent has to be kept and when it has to be removed. It is hoped that refined indications and newer materials would result in a technically improved variety, thus making stents both physician and patient friendly.

AUTOFLUORESCENCE BRONCHOSCOPY

Lam and coworkers developed a real-time diagnostic imaging system based on natural autofluorescence of early

bronchogenic carcinoma and precancerous lesions.[25] The principle applied is that, when light of certain wavelength is directed on objects with intrinsic fluorescent ability (fluorophores), light of a longer wavelength is remitted. Upon excitation by violet or blue light, there is a significant reduction in autofluorescence intensity from premalignant or malignant tissues compared to normal tissue. Normal mucosa is arbitrarily assigned a green color, while a red or brownish red identifies precancerous and early cancer lesions. Thus, the physician is able to determine the area for biopsy more accurately. In carcinoma *in situ* or dysplasia, both the intensity of emitted light is weaker and the light compositions altered in favor of red spectrum.

INDICATIONS FOR FLUORESCENCE ENDOSCOPY

1. When atypical cells or cells suspected of malignancy in sputum or bronchial aspirate are obtained.
2. Presence of a suspicious lung shadow or infiltrate on plain chest skiagram.
3. Nondiagnostic white light bronchoscopy results.
4. Inspection for synchronous tumors.
5. Surveillance following cancer resection.[26]
6. Primary screening among high-risk patients like smokers and workers, who are industrially exposed.
7. As a guide to bronchoscopic biopsy and endoscopic treatment.
8. Investigating the effects of chemopreventive agents.
9. Recommended as a diagnostic tool in patients with a prior diagnosis of squamous cell carcinoma of head, neck, lung or any other site at every 1 year interval.[27]

Potential advantages include high signal sensitivity, accessibility to various parts of bronchial tree with small diameter optical fiberoptic probes, reduction in the use of random tissue biopsies and ease of use. The lung imaging fluorescence endoscope device (LIFE) has a 72.5 percent sensitivity and 94 percent specificity, representing a 50 percent improvement over white light bronchoscopy in detecting carcinoma *in situ* or dysplasia.[28,29] Its main limitation is the range of the bronchoscope, which cannot access the outer third of the lung and identify early peripheral lesions.

In a nutshell, autofluorescence bronchoscopy plays an important role in the localization of preinvasive and early invasive lung cancer,[30-33] as a guide to bronchoscopic biopsy and endoscopic treatment and for investigating the effect of chemopreventive agents. Much remains to be done to move these techniques into routine clinical practice.

ENDOBRONCHIAL ULTRASOUND

The basis, for the use of ultrasonography in the tracheobronchial tree is the techniques theoretical ability, to identify submucosal changes and lesions adjacent (extrabronchial) to the airways. The device consists of an echographic camera, a transbronchoscopic ultrasonic probe, a video monitor to visualize the echographic image and the facility to develop echo enhancements. Endobronchial ultrasonography may help in early detection of mucosal cancer and identification of paratracheal, hilar or mediastenal lymph nodes. Endobronchial ultrasound-guided, transbronchial needle aspiration (EBUS-TBNA) has been available for more than 5 years. Several authors,[34–36] have reported that EBUS-TBNA is a highly accurate and safe method for sampling enlarged mediastinal lymph nodes.These authors also reported that the rate of successful biopsies leading, to correct predictions of lymph node staging in lung cancer is higher with EBUS-TBNA than it is with other endoscopy modalities.[34-37] The major obstacle to the use of bronchoscopic ultrasonography is the inability to maintain fluid bronchial mucosal interphase during the procedure. Therefore, the tumors within the lung parenchyma are difficult to identify. Nevertheless endobronchial ultrasound holds much promise.

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CHAPTER

16 Case Reports—Bronchoscopic Findings in Benign Pulmonary Diseases

CASE 1: ENDOBRONCHIAL POLYP IN A 25-YEAR-OLD FEMALE

This patient, presented with recurrent cough with expectoration and hemoptysis for last 10 years. She was given many courses of antituberculous treatment without any response. Fiberoptic bronchoscopy showed pedunculated polyp obstructing the bronchus intermedius freely moving with respiration. Pus was also seen around polyp. Polyp was removed with the help of rigid bronchoscope histology of which was suggestive of myxomatous polyp (Figs 16.1 to 16.4).

Fig. 16.1: Chest X-ray showing collapse right middle and lower lobe

CASE 2: BRONCHIAL CARCINOID IN A 22-YEAR-OLD FEMALE

This patient, presented with recurrent fever, cough, with expectoration and moderate to massive hemoptysis for last 12 years and was misdiagnosed as pulmonary tuberculosis by many doctors and had received many courses of antitubercular drugs without any response. Fiberoptic bronchoscopy showed a tumor obstructing right main bronchus. Endobronchial biopsy showed bronchial carcinoid (Figs 16.5 to 16.11).

CASE 3: CARCINOID TUMOR IN A 26-YEAR-OLD MALE

This patient, *bidi* smoker (5 bidi/day for last 6 years) presented with cough, fever, hemoptysis for last 1 year and was misdiagnosed as tuberculosis and was given

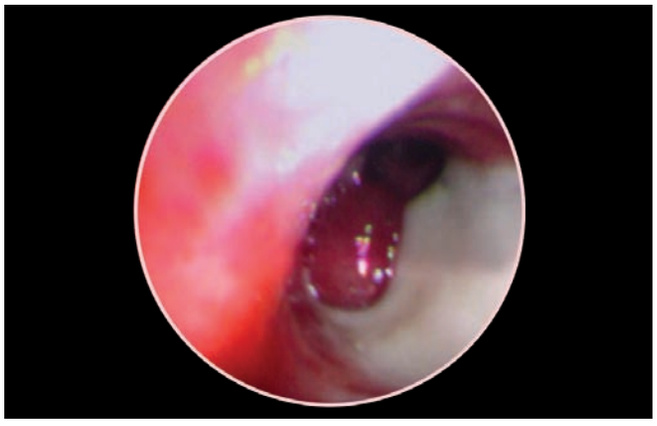

Fig. 16.2: Polyp covered with pus

Bidis are hand rolled in cottage industries by wrapping a small amount of sun cured Indian tobacco in nonporous "Tendu" leaves (*Diospyros melanoxylon* or *Diospyros ebenun*). The finished product resembles a narrow tapered, brown unfiltered cigarette.

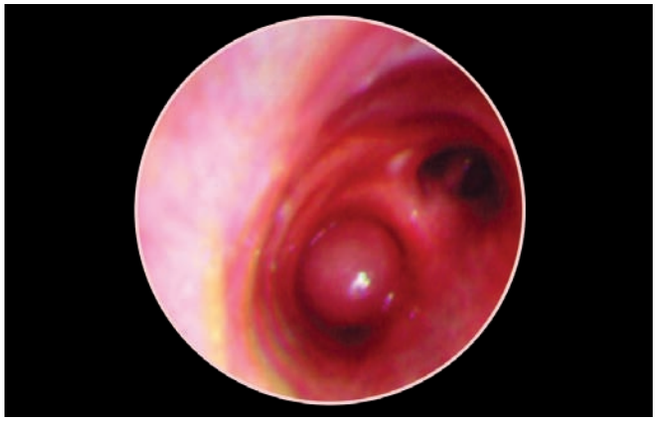

Fig. 16.3: Endobronchial polyp during expiration

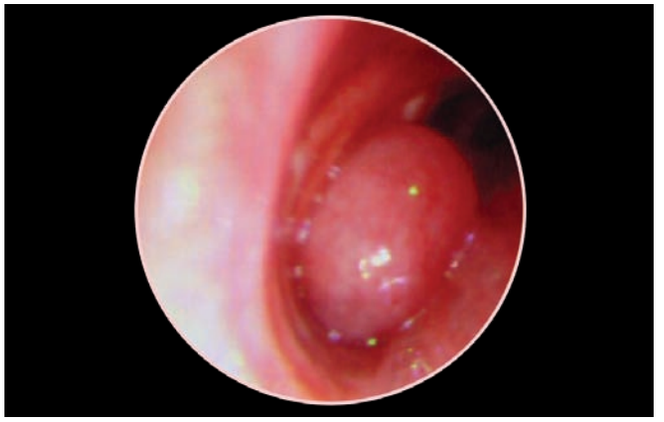

Fig. 16.4: Endobronchial polyp during inspiration

Fig. 16.5: Chest X-ray showing radio-opaque shadow with volume reduction on right side

Fig. 16.6: Chest X-ray showing collapse of right lung

Fig. 16.7: Chest X-ray showing collapse of right lung

Fig. 16.8: Chest X-ray showing collapse of right lung

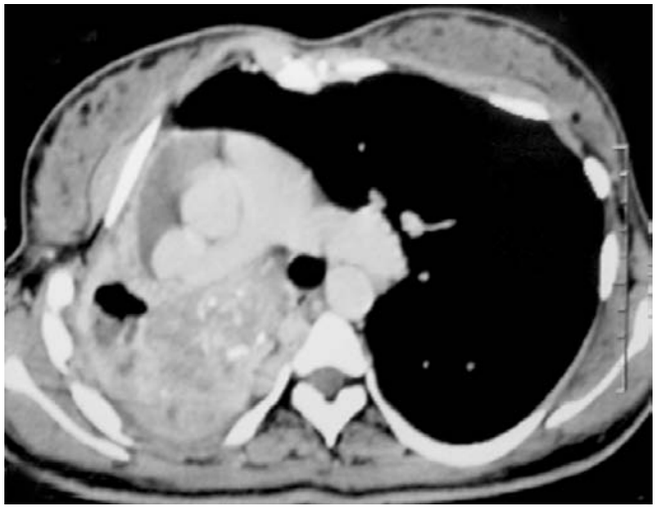

Fig. 16.9: CT thorax showing heterogeneous enhancing soft-tissue mass in right lung

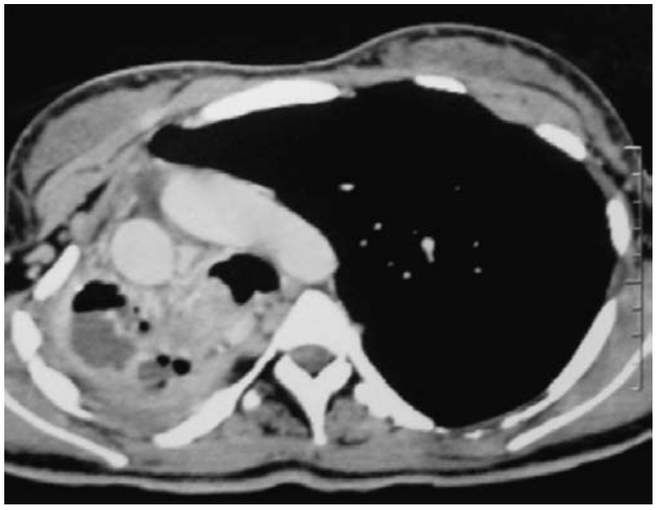

Fig. 16.10: CT thorax showing heterogeneous enhancing soft-tissue mass in right lung

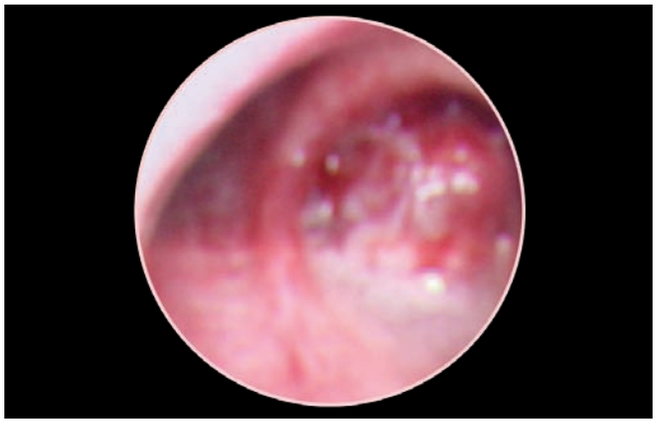

Fig. 16.11: Tumor obstructing right main bronchus with distortion of main carina

antitubercular treatment for 1 year without any response. Fiberoptic bronchoscopy showed a polypoidal growth in left main bronchus. Growth was removed with the help of rigid bronchoscope. Biopsy of the growth revealed carcinoid tumor (Figs 16.12 to 16.15).

CASE 4: RUPTURED HYDATID CYST IN A 31-YEAR-OLD MALE

This patient, nonsmoker presented with recurrent hemoptysis for last 2 years and was misdiagnosed as tuberculosis and was given antitubercular treatment for 1 year without any response. Fiberoptic bronchoscopy showed a whitish material in anterior and lateral basal segments of the right lower lobe. Bronchial aspiration was done and whitish membranous structure was aspirated. Right lower lobe lobectomy was done and histopathology showed ruptured hydatid cyst (Figs 16.16 to 16.27).

CASE 5: SARCOIDOSIS IN A 45-YEAR-OLD MALE

This patient, non-smoker, presented with mild fever, loss of appetite for last 18 months and was misdiagnosed as tuberculosis and was given antitubercular treatment for 9 months without any response. Fiberoptic bronchoscopy showed hyperemic tracheobronchial tree with thickening of main carina with granulations. Histopathology of endobronchial biopsy (EBB) of main carina was consistent with sarcoidosis (Figs 16.28 to 16.31).

CASE 6: SARCOIDOSIS IN A 38-YEAR-OLD FEMALE

This patient, with past history of cytology proven right supraclavicular tuberculous lymphadenopathy received antitubercular treatment for 9 months, 5 years back with good response, presented now with complaints of dry cough, with progressively increasing breathlessness for last one year. She was again prescribed antitubercular treatment for 6 months without any response. Fiberoptic

Fig. 16.12: Apparently normal looking chest X-ray with volume reduction on left side

Fig. 16.13: CT thorax showing soft-tissue shadow in left main bronchus

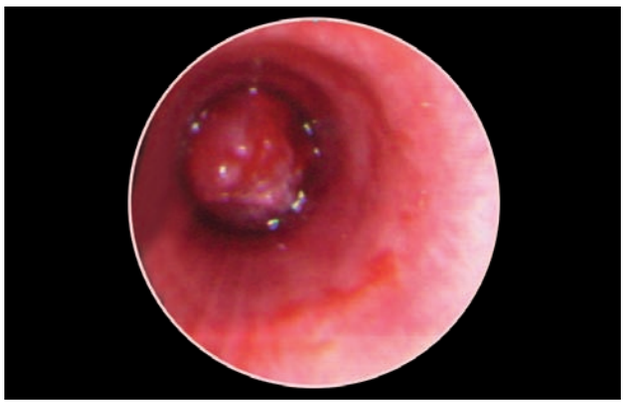

Fig. 16.14: Multilobular tumor in left main bronchus

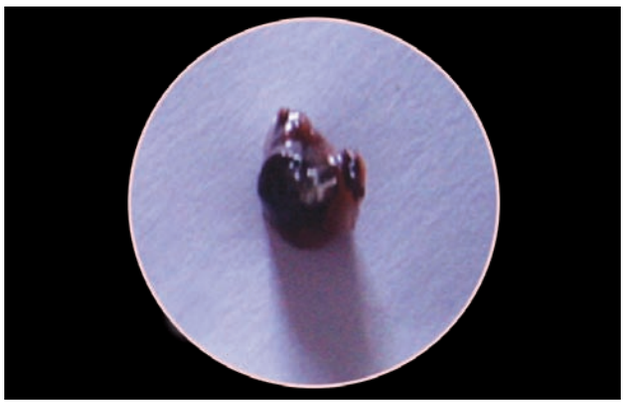

Fig. 16.15: Tumor taken out through rigid bronchoscope

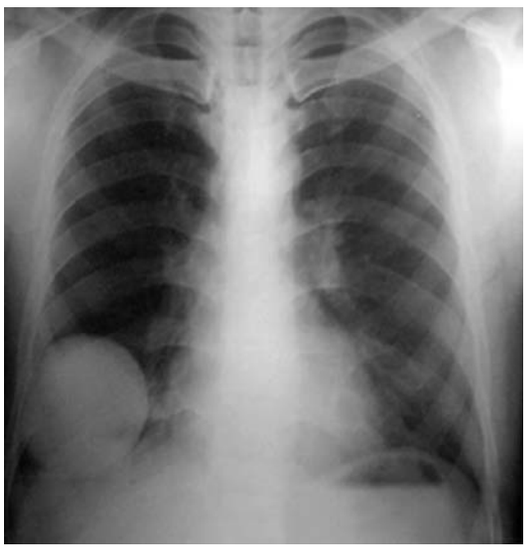

Fig. 16.16: Chest X-ray showing well-circumscribed rounded opacity in right lower zone

Fig. 16.17: Chest X-ray showing ruptured hydatid cyst

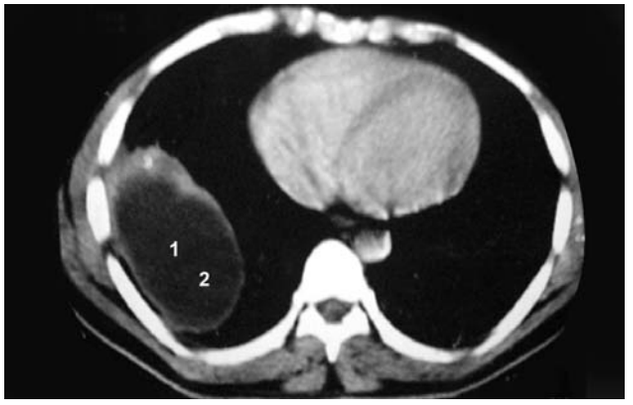

Fig. 16.18: CT thorax showing hydatid cyst

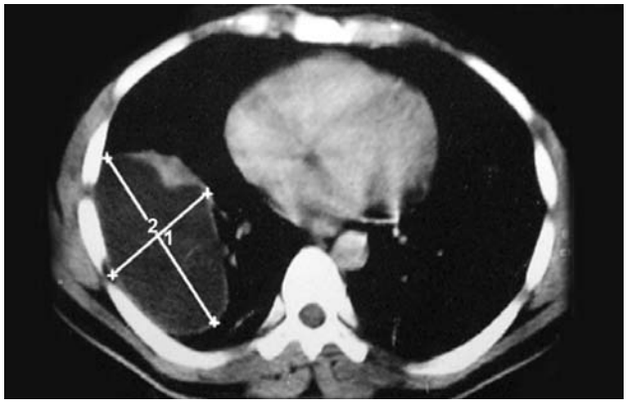

Fig. 16.19: CT thorax showing hydatid cyst

Fig. 16.20: Chest X-ray showing ruptured hydatid cyst

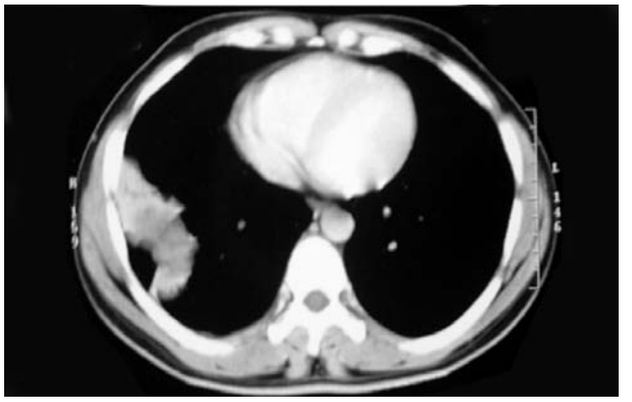

Fig. 16.21: CT thorax showing ruptured hydatid cyst

Fig. 16.22: Chest X-ray showing ruptured hydatid cyst

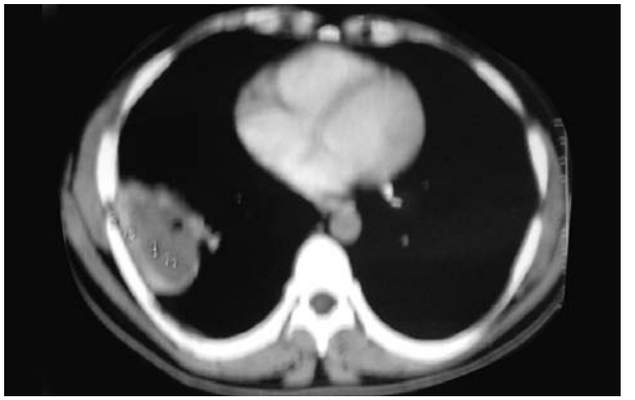

Fig. 16.23: CT thorax showing ruptured hydatid cyst

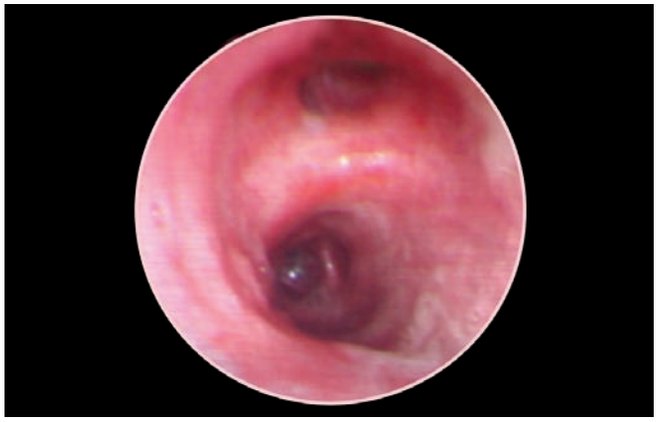

Fig. 16.24: Hyperemic mucous membrane

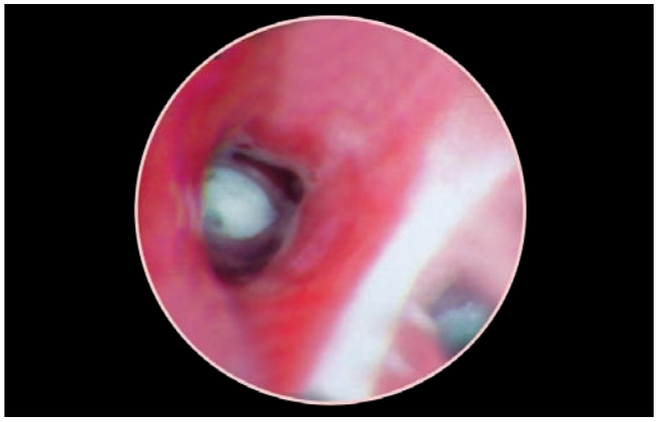

Fig. 16.25: Whitish material in anterior and lateral basal segment of the right lower lobe

Fig. 16.26: Whitish material in anterior and lateral basal segment of the right lower lobe

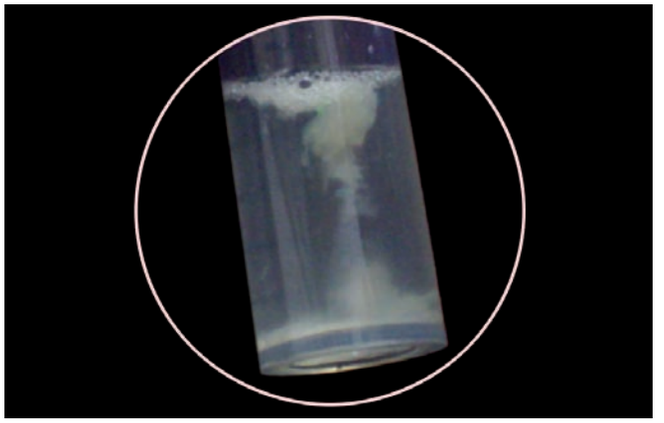

Fig. 16.27: Whitish membranous structure in bronchial aspirate

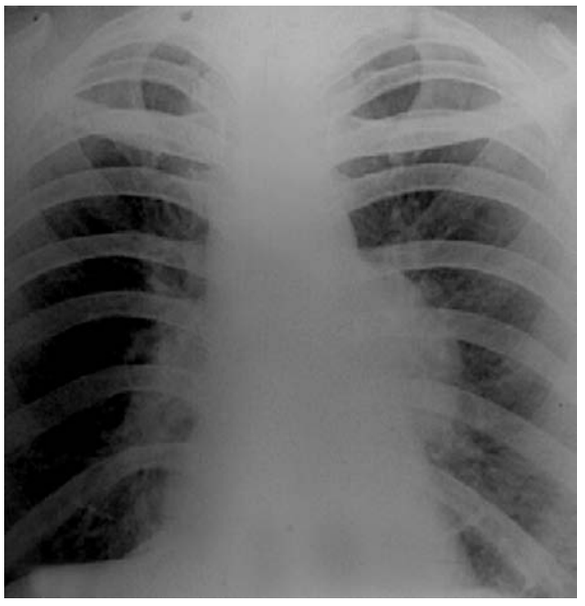

Fig. 16.28: Chest X-ray showing hilar glands on left side

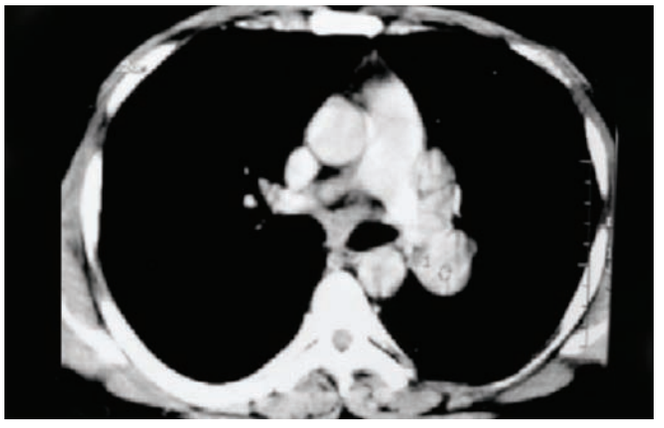

Fig. 16.29: CT thorax showing hilar glands on left side

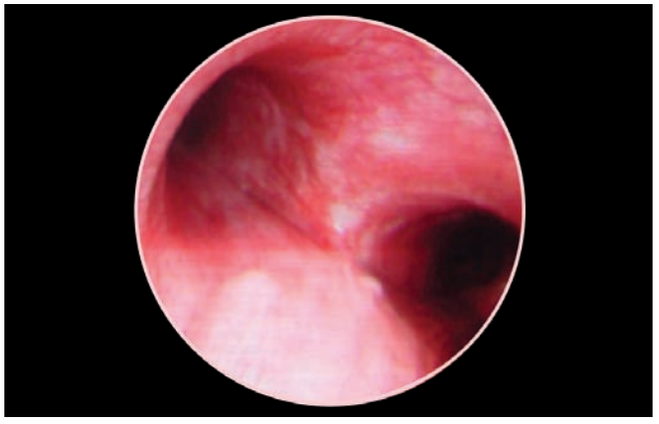

Fig. 16.30: Wide and hyperemic main carina with granular appearance

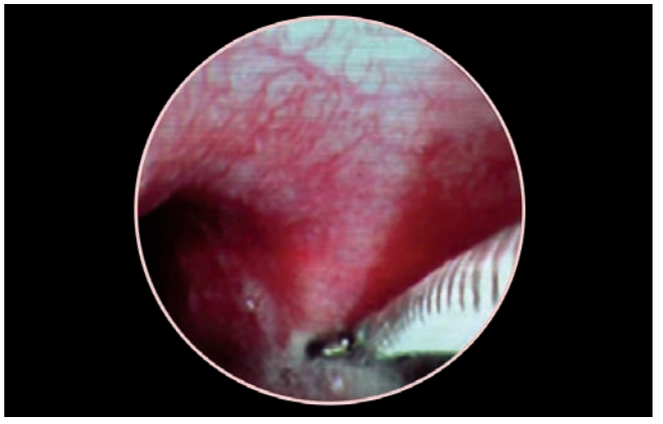

Fig. 16.31: Spider web pattern of hyperemia with endobronchial forceps in position

bronchoscopy showed hyperemic endobronchial tree. Histopathology of transbronchial lung biopsy showed non-caseating granuloma consistent with sarcoidosis. Her serum angiotensin converting enzyme (SACE) was 144 IU/L and mantoux test was 2.0 mm. She was treated with oral steroids and responded well (Figs 16.32 to 16.39).

CASE 7: LYMPHO TRACHEAL FISTULA IN A 30-YEAR-OLD MALE

This patient, non-smoker, known case of diabetes mellitus not properly controlled for last 6 years, presented with dry cough, fever, breathlessness and loss of appetite for last 3 months. Computed tomography (CT) thorax showed multiple caseating mediastinal lymph nodes. Fiberoptic bronchoscopy showed fistula at lower end of trachea, surrounded by granulation tissue just before the main carina. Endobronchial biopsy from granulation tissue showed histopathology suggestive of tuberculosis. He was given antitubercular treatment (ATT) for 9 months along with antidiabetic treatment. Mediastinal lymph nodes disappeared and fistula also healed (Figs 16.40 to 16.47).

CASE 8: ENDOBRONCHIAL TUBERCULOSIS IN A 30-YEAR-OLD FEMALE

This patient, nonsmoker, presented with cough with expectoration, fever, chest pain and loss of appetite for last 6 months. Fiberoptic bronchoscopy showed one small and one large nodule in bronchus intermedius. Mucous membrane around nodules were hyperemic. Transbronchial needle aspiration (TBNA) was done and caseous material came out, which was positive for acid-fast bacillus. Patient responded with antitubercular treatment (Figs 16.48 to 16.55).

CASE 9: ENDOBRONCHIAL TUBERCULOSIS IN A 26-YEAR-OLD FEMALE

This patient, non-smoker, known diabetic presented with cough, high fever, chest pain for last 15 days. Her sputum was repeatedly negative for acid-fast bacillus. She was prescribed antibiotics for 10 days with out any response. Fiberoptic bronchoscopy showed edematous and hyperemic tertiary carina near posterior segment of right upper lobe. Lumen of the same segment was also narrowed. Bronchial aspirate from same segment was positive for acid-fast bacillus (AFB). Patient was given antidiabetic and antitubercular treatment and responded (Figs 16.56 to 16.59).

CASE 10: ENDOBRONCHIAL TUBERCULOSIS IN A 44-YEAR-OLD FEMALE

This patient, non-smoker, presented with cough and hemoptysis for last 3 months. Sputum smear was repeatedly negative for acid-fast bacillis (AFB). Fiberoptic bronchoscopy showed edematous and hyperemic secondary carina near right upper lobe bronchus, which was filled with necrotic material and blood. Bronchial aspirate and brush biopsy were positive for AFB and

Fig. 16.32: Chest X-ray showing bilateral diffuse lung shadows

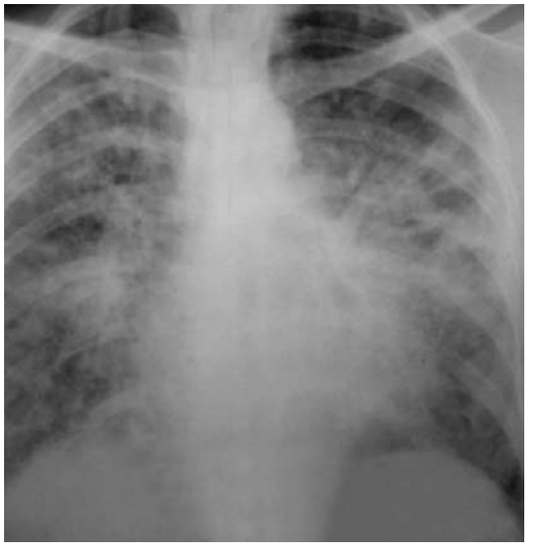

Fig. 16.33: Chest X-ray showing increased bilateral diffuse lung shadows

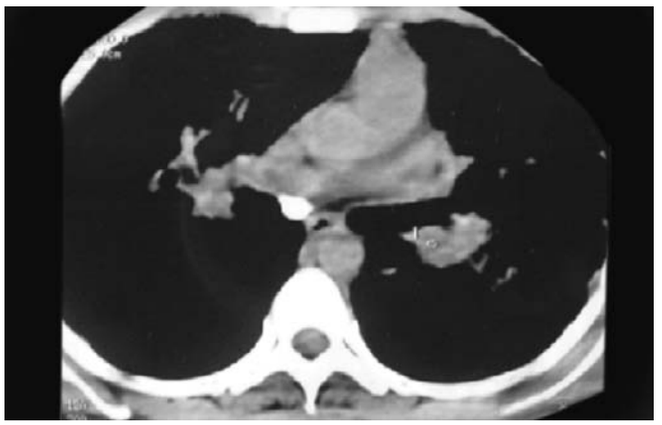

Fig. 16.34: CT thorax showing hilar glands with calcified mediastinal lymph node

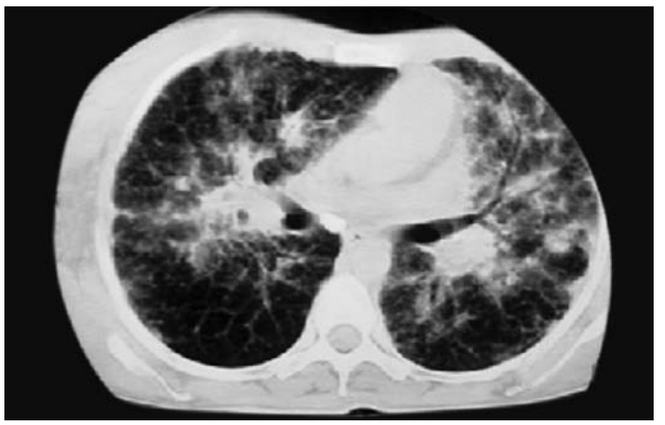

Fig. 16.35: CT thorax showing bilateral diffuse lung shadows

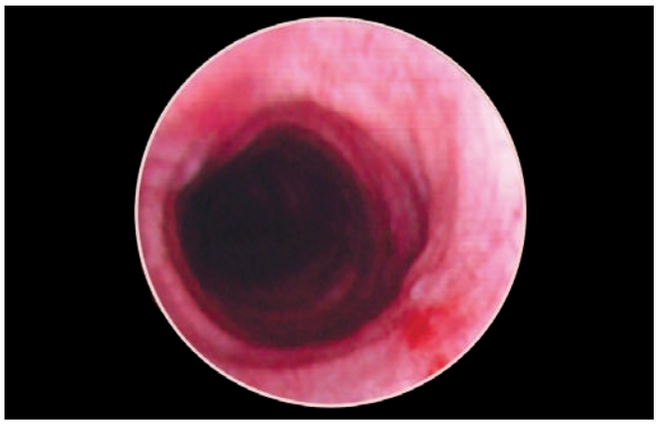

Fig. 16.36: Hyperemic endobronchial tree

Fig. 16.37: Hyperemic endobronchial tree

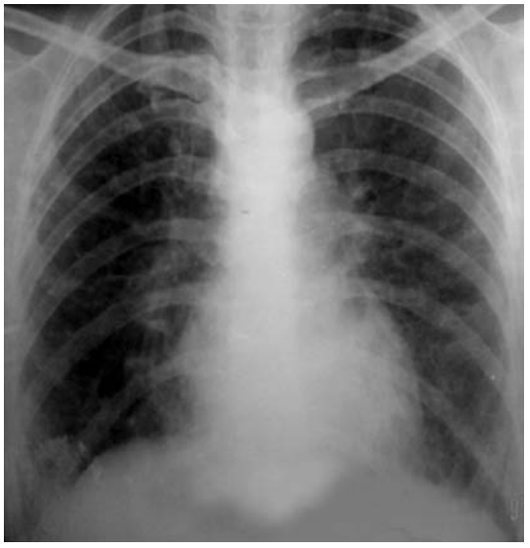

Fig. 16.38: Chest X-ray showing response after oral steroids

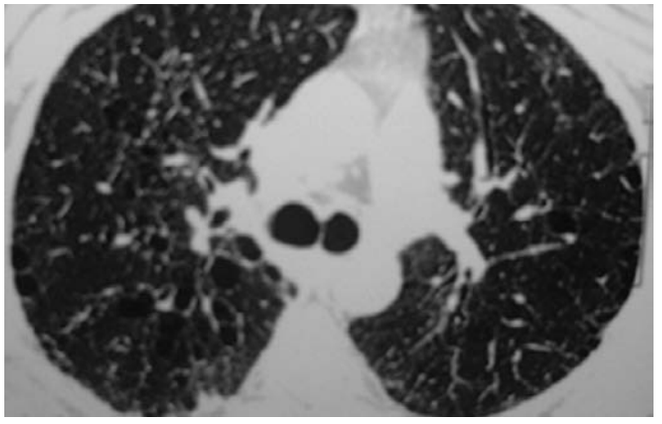

Fig. 16.39: CT thorax showing response after oral steroids

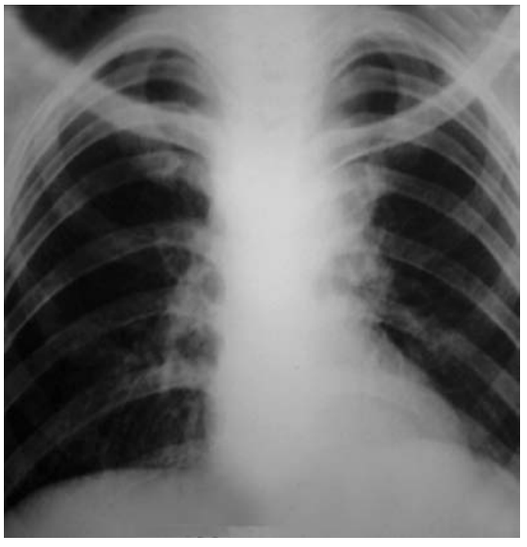

Fig. 16.40: Apparently normal looking chest X-ray

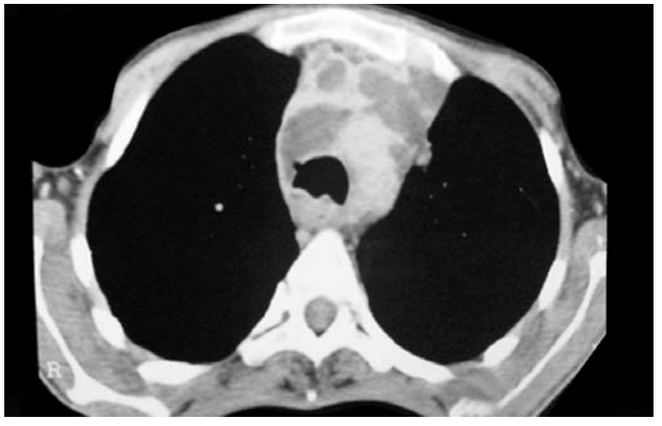

Fig. 16.41: CT thorax showing multiple caseating mediastinal lymph nodes with irregular tracheal outline

Fig. 16.42: CT thorax showing fistulous track

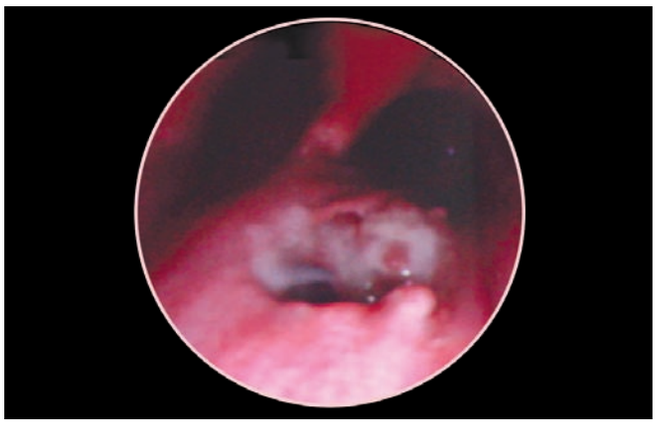

Fig. 16.43: Tracheal fistula surrounded with granulation tissue

Fig. 16.44: Chest X-ray after ATT

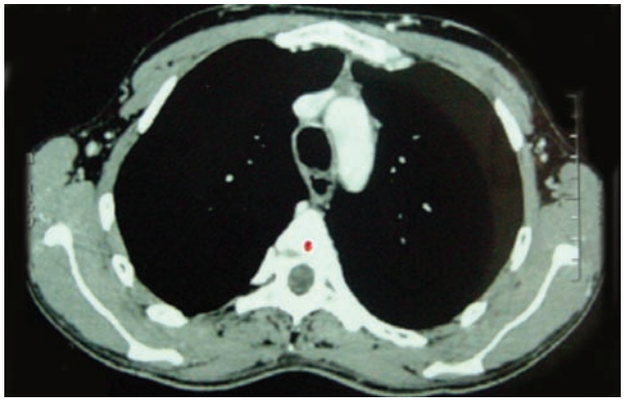

Fig. 16.45: CT thorax showing disappearance of mediastinal glands

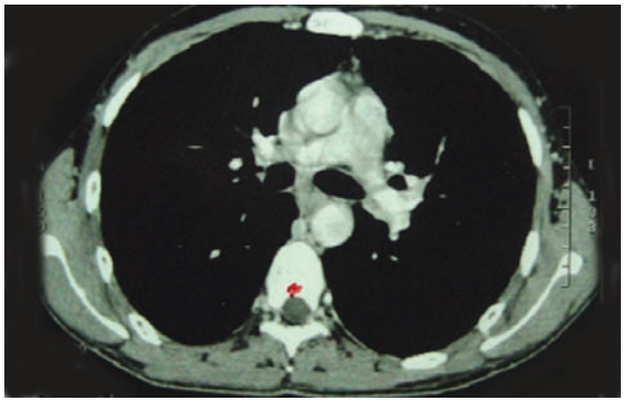

Fig. 16.46: CT thorax showing fistulous track being closed

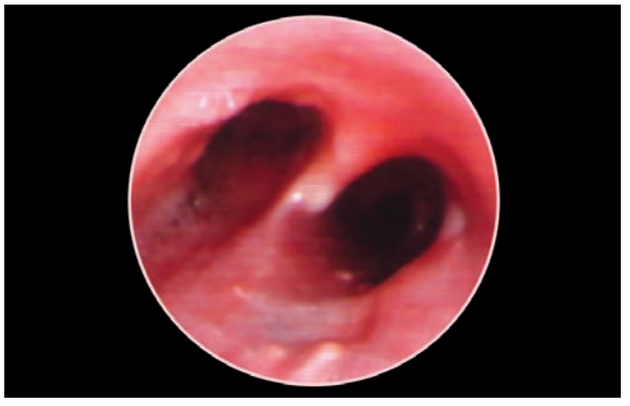

Fig. 16.47: Fistula closed and healed

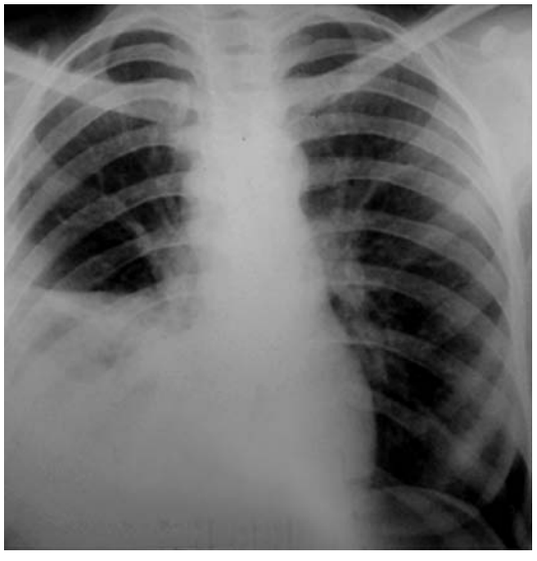

Fig. 16.48: Chest X-ray showing obstructive pneumonitis right middle and lower zone

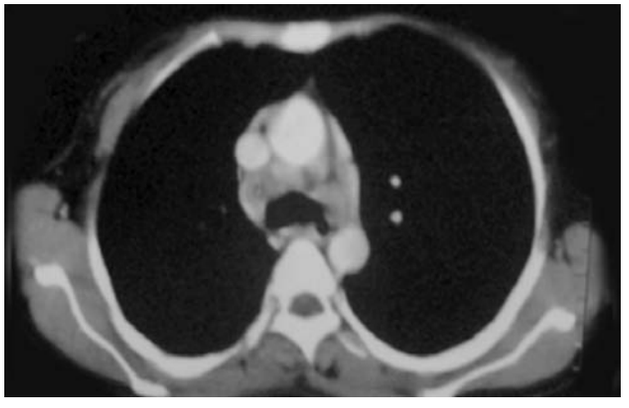

Fig. 16.49: CT thorax showing mediastinal lymphadenitis

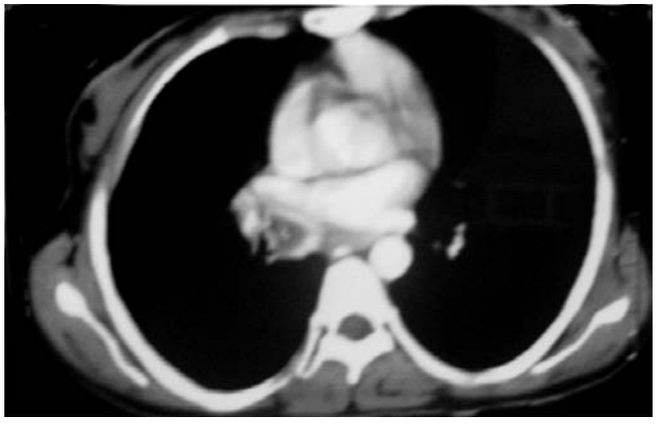

Fig. 16.50: CT thorax showing mediastinal lymphadenitis

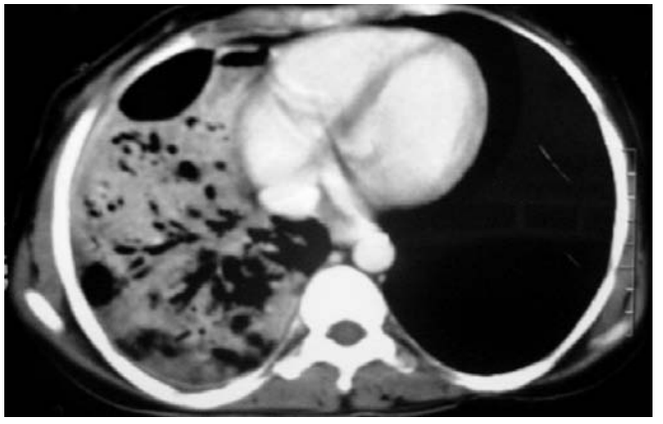

Fig. 16.51: CT thorax showing pneumonitis

Fig. 16.52: Two nodular growths

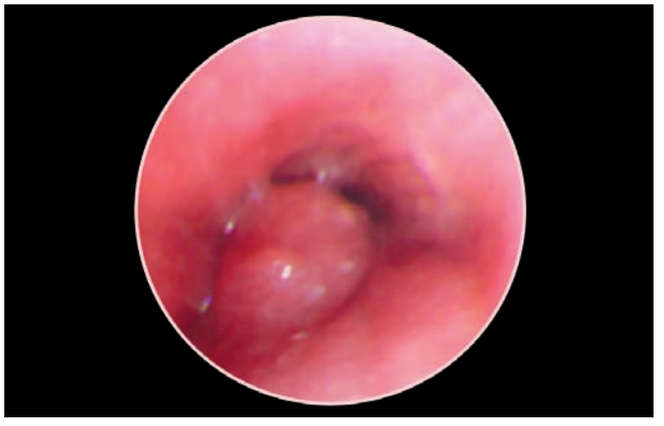

Fig. 16.53: Close view of nodule

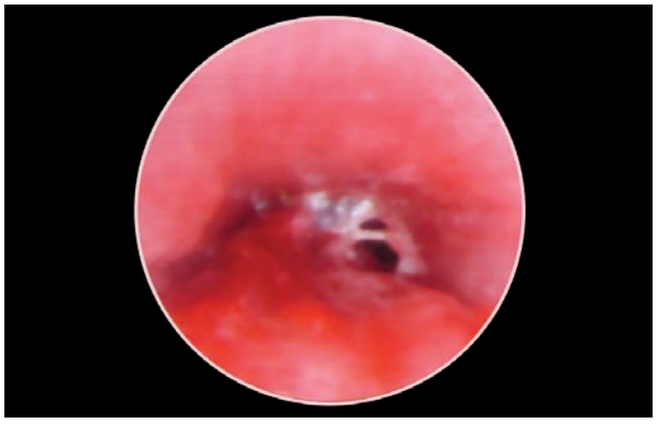

Fig. 16.54: Caseous material after transbronchial needle aspiration

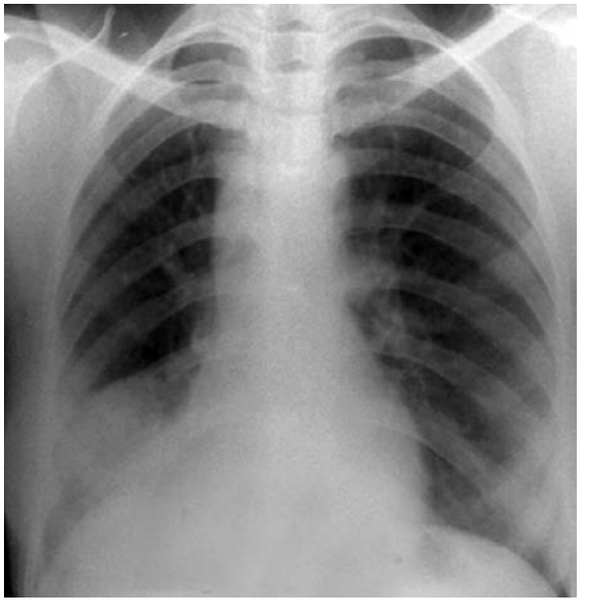

Fig. 16.55: Chest X-ray after ATT

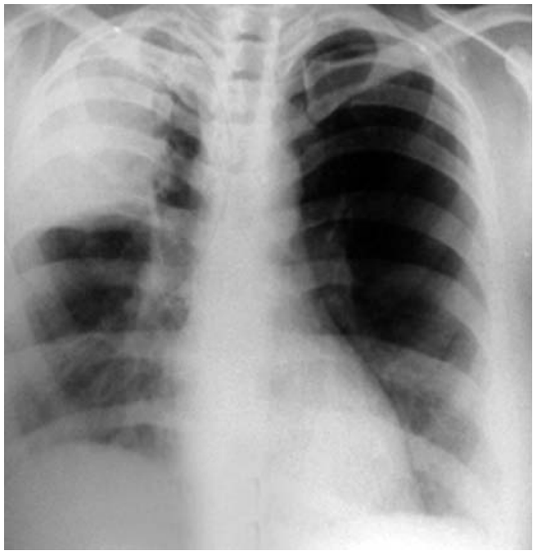

Fig. 16.56: Chest X-ray showing pneumonia on right side

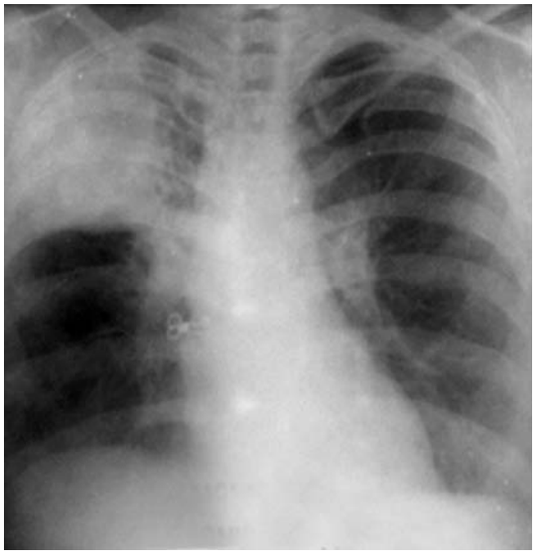

Fig. 16.57: Chest X-ray showing no response after antibiotics

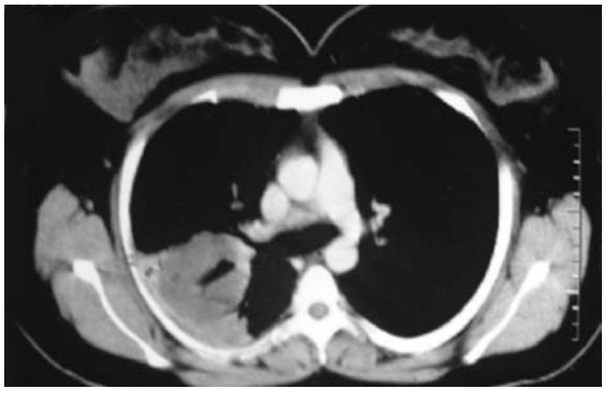

Fig. 16.58: CT thorax showing mass like lesion with central necrosis

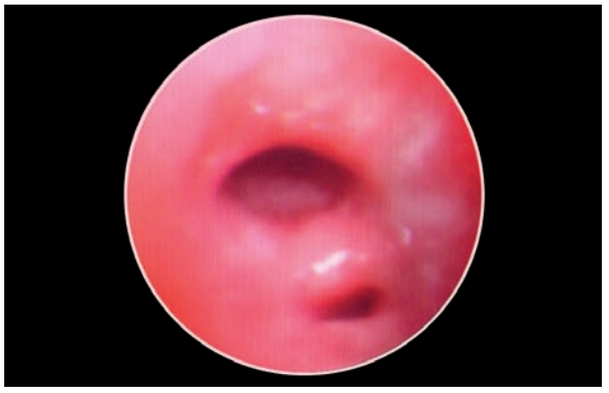

Fig. 16.59: Edematous and hyperemic tertiary carina

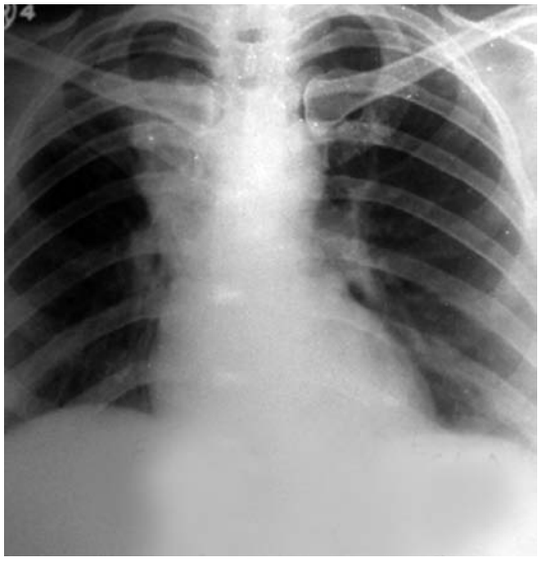

Fig. 16.60: Chest X-ray showing homogenous radio-opaque shadow in right paratracheal area

endobronchial biopsy from right upper lobe was consistent with histopathology of tuberculosis. She responded with antitubercular treatment (Figs 16.60 to 16.63).

CASE 11: ENDOBRONCHIAL TUBERCULOSIS IN A 44-YEAR-OLD MALE

This patient, a bidi smoker (10/day for 20 years) presented with cough and recurrent hemoptysis for last 2 months. Sputum smear was repeatedly negative for AFB. Fiberoptic bronchoscopy showed blood clots in left main bronchus. Left lower lobe bronchial mucous membrane was hyperemic and hypertrophied. There was a pit like ulcer in anteromedial wall of left lower lobe bronchus (pit and basket like appearance). Bronchial aspirate was positive for AFB. Endobronchial biopsy from pit like ulcer was consistent with histopathology of tuberculosis (Figs 16.64 to 16.67).

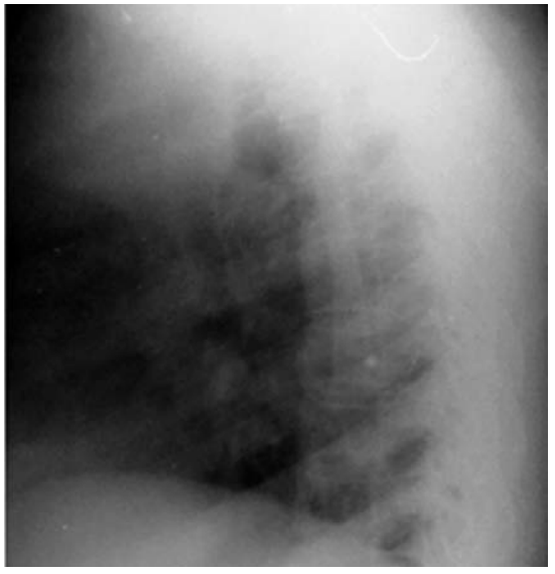

Fig. 16.61: Chest X-ray lateral view showing mass like shadow in right upper lobe

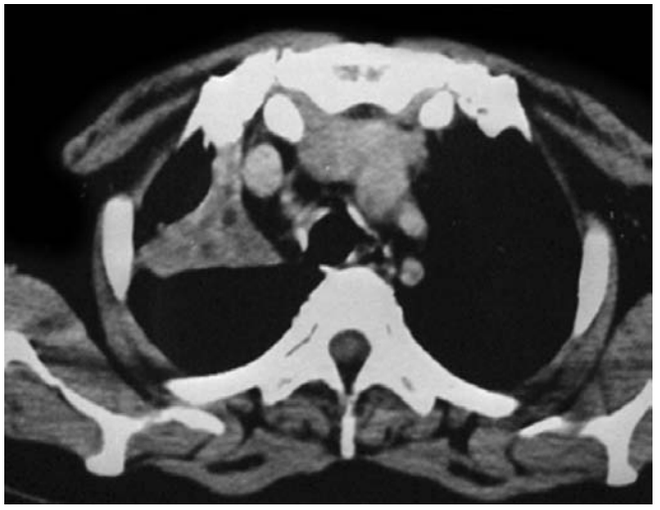

Fig. 16.62: CT thorax showing triangular opacity with irregular caseation

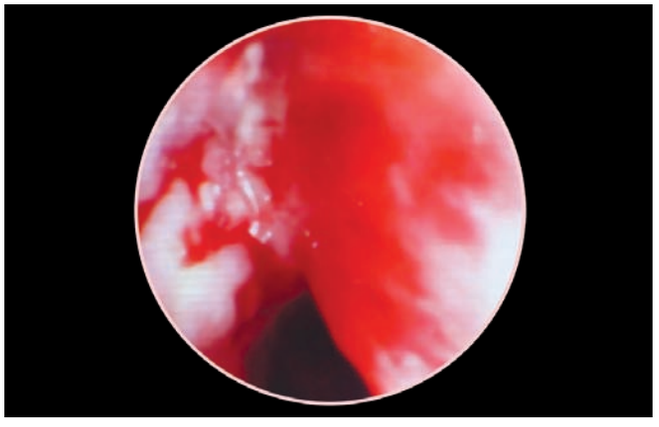

Fig. 16.63: Right upper lobe bronchus obstructed by caseous material and blood

Fig. 16.64: Chest X-ray looking normal

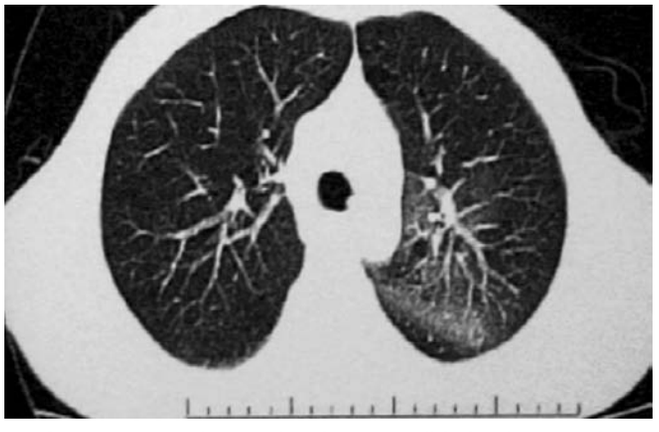

Fig. 16.65: CT thorax showing consolidation in posterior segment of left upper lobe

CASE 12: TUBERCULOUS ENDOBRONCHIAL SINUS IN A 21-YEAR-OLD MALE

This patient, non-smoker presented with fever, dry cough, loss of appetite and dysphagia for last 2 months. Fiberoptic bronchoscopy showed bulging of posterior wall of lower end of trachea near main carina. There were three sinuses with blackish margins and with surrounding hyperemia

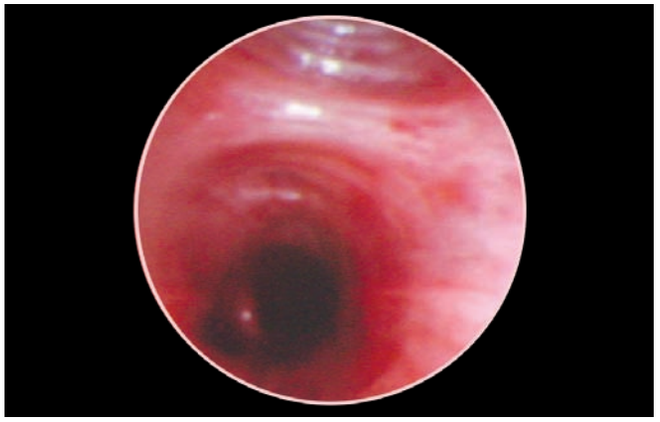

Fig. 16.66: Hypertrophied and hyperemic mucous membrane with pit like ulcer

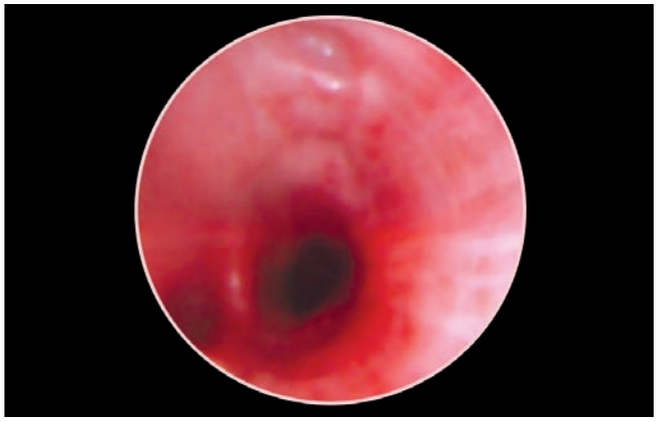

Fig. 16.67: Pit and basket like appearance

Fig. 16.68: Chest X-ray showing mediastinal widening

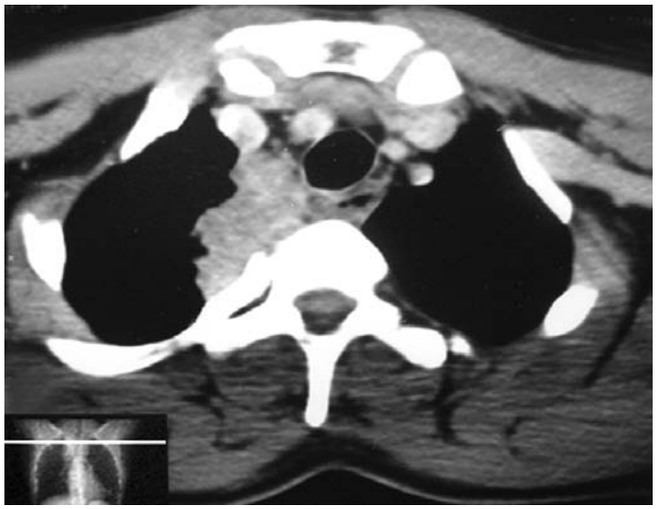

Fig. 16.69: CT thorax showing large heterogeneous mass in right paratracheal and retrotracheal areas

just behind the secondary carina, near the upper lobe bronchus. Endobronchial biopsy from the sinuses showed histopathology of tuberculosis (Figs 16.68 to 16.75).

CASE 13: CHRONIC BRONCHITIS IN A 50-YEAR-OLD MALE

This patient a smoker (25 bidi/day for 30 years) presented with cough with expectoration off-and-on for 5 years and breathlessness for last 2 years and mild hemoptysis for last 1 month. Fiberoptic bronchoscopy showed circular mucosal folds with pits suggesting mucosal hypertrophy. The bronchial mucosa was hyperemic (Figs 16.76 to 16.77).

CASE 14: BRONCHIECTASIS IN A 30-YEAR-OLD MALE

This patient nonsmoker presented with recurrent cough with expectoration and hemoptysis for last 15 years. Fiberoptic bronchoscopy showed pus in right Endobronchial tree. Chest X-ray and CT scan showed bronchiectatic changes (Figs 16.78 to 16.81).

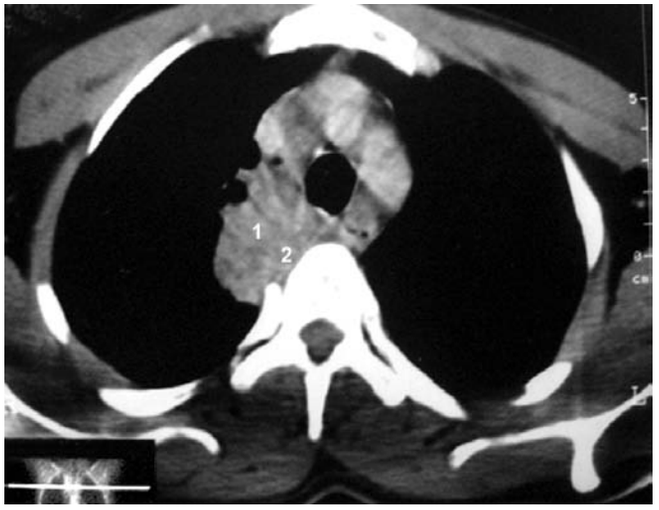

Fig. 16.70: CT thorax showing large heterogeneous mass in right paratracheal and retrotracheal areas

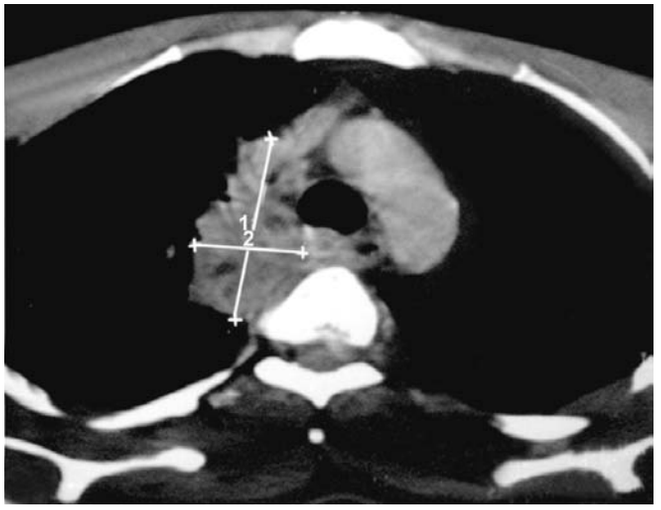

Fig. 16.71: CT thorax showing large heterogeneous mass in right paratracheal and retrotracheal areas

Fig. 16.72: Bulging of posterior wall of lower end of trachea

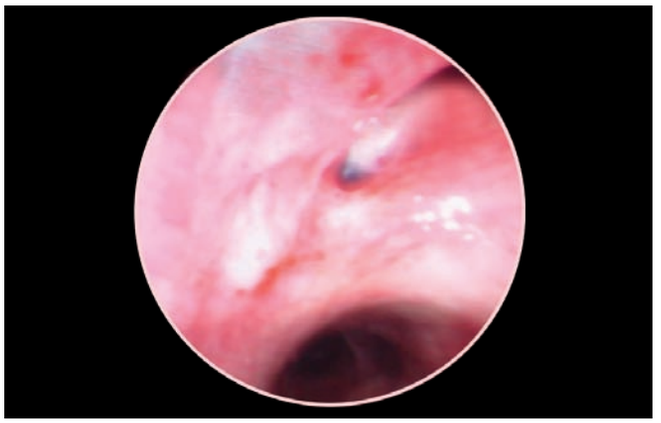

Fig. 16.73: Tuberculous sinus

Fig. 16.74: Tuberculous sinus just behind secondary carina

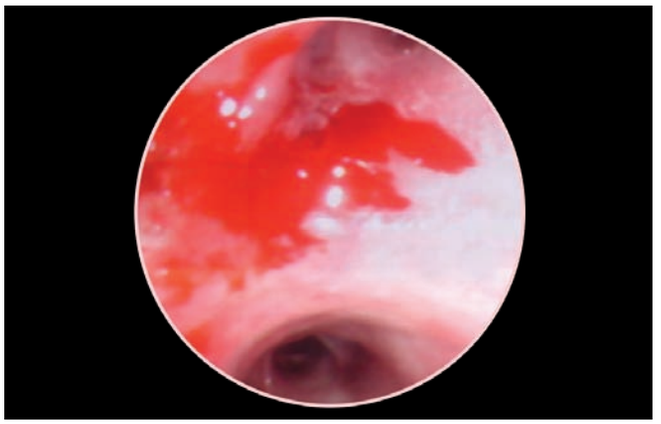

Fig. 16.75: Bleeding after endobronchial biopsy

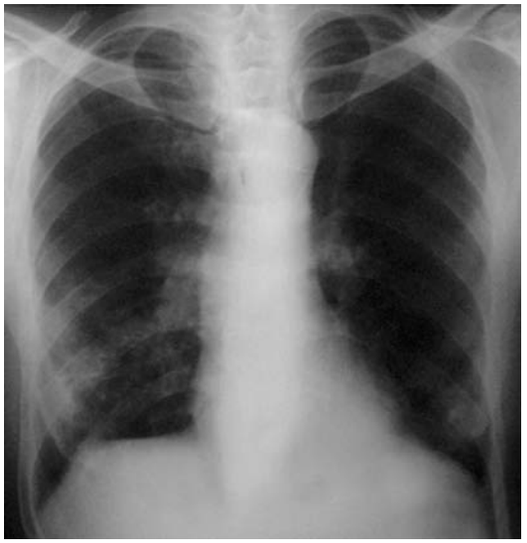

Fig. 16.76: Chest X-ray—normal looking

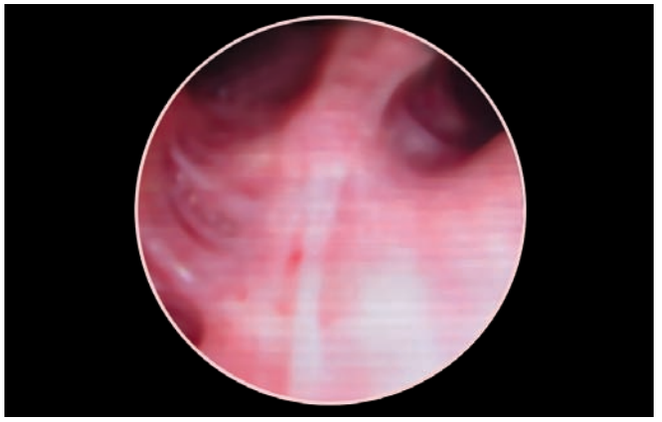

Fig. 16.77: Prominent circular mucosal folds with pits

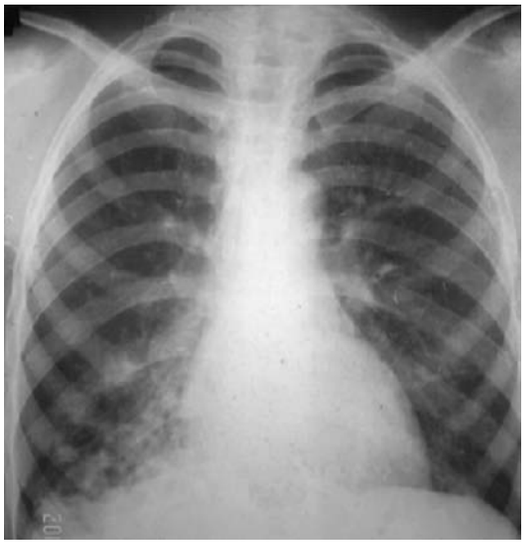

Fig. 16.78: Chest X-ray PA view suggestive of bronchiectasis on right side

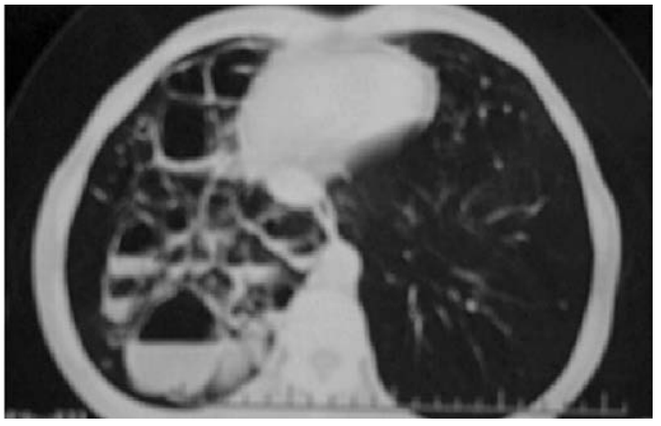

Fig. 16.79: CT thorax showed bronchiectasis right side

Fig. 16.80: Pus in right main bronchus

Fig. 16.81: Pus in right lower lobe

CASE 15: BRONCHIECTASIS IN A 50-YEAR-OLD MALE

This patient, nonsmoker presented with recurrent hemoptysis and cough with expectoration for last 20 years. Chest X-ray showed no obvious abnormality. Fiberoptic bronchoscopic showed fresh blood in left endobronchial tree. CT thorax confirmed the diagnosis of bronchiectasis on left side (Figs 16.82 to 16.85).

Fig. 16.82: Chest X-ray looking normal

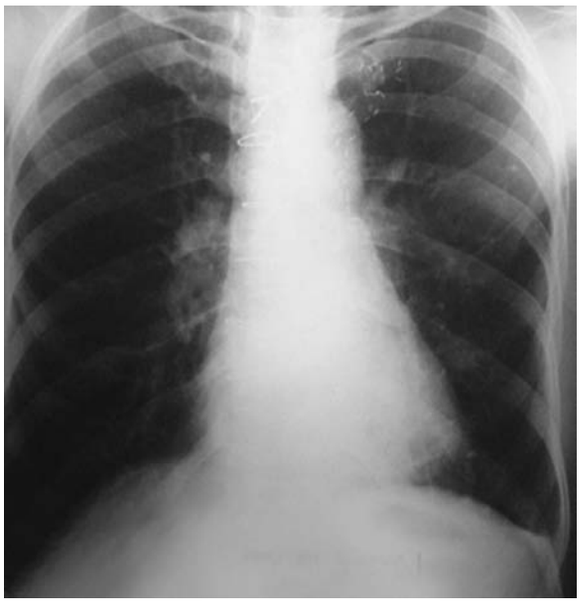

Fig. 16.83: Chest X-ray looking normal

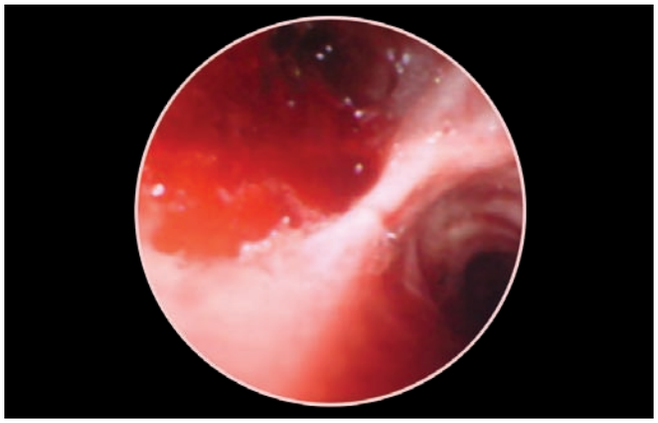

Fig. 16.84: Fresh blood in left endobronchial tree

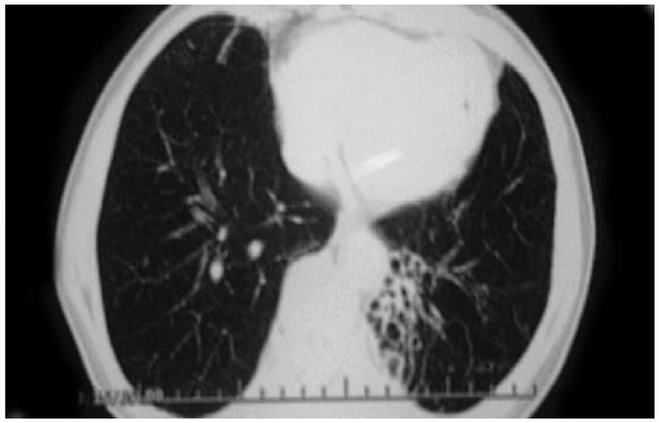

Fig. 16.85: CT thorax showing bronchiectasis in left lower lobe

CHAPTER

17

Case Reports—Bronchoscopic Findings in Malignant Pulmonary Diseases

CASE 16: SQUAMOUS CELL CARCINOMA IN A 51-YEAR-OLD MALE

This patient, bidi smoker (20 bidis/day for last 25 years) presented with fever, cough and recurrent hemoptysis (streaking) for last 1 year and fiberoptic bronchoscopy showed wide main carina and a growth in the left main bronchus. Histopathology of endobronchial and brush biopsy was consistent with squamous cell carcinoma (Figs 17.1 to 17.4).

CASE 17: SQUAMOUS CELL CARCINOMA IN A 53-YEAR-OLD MALE

This patient, non-smoker had presented with cough and expectoration, fever and loss of appetite and weight loss, since last 6 months. Fiberoptic bronchoscopy showed tumor obstructing right upper lobe bronchus. Histopathology of endobronchial biopsy was consistent with squamous cell carcinoma (Figs 17.5 to 17.8).

CASE 18: SQUAMOUS CELL CARCINOMA IN A 58-YEAR-OLD MALE

This patient, bidi smoker (15 bidis/day for last 30 years) and known case of chronic obstructive pulmonary disease (COPD) for last 6 years, presented with recurrent hemoptysis and loss of appetite for last 7 months. Fiberoptic bronchoscopy showed clotted blood in left main bronchus. After the removal of clotted blood, there was a tumor visible in left main bronchus. Histopathology of endobronchial biopsy of the tumor was consistent of squamous cell carcinoma (Figs 17.9 to 17.12).

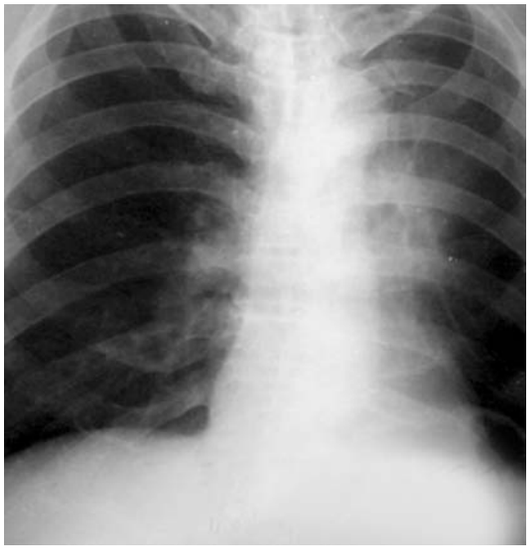

Fig. 17.1: Chest X-ray showing mass in parahilar area on left side

Fig. 17.2: CT thorax mass with multiple necrotic areas in left lung

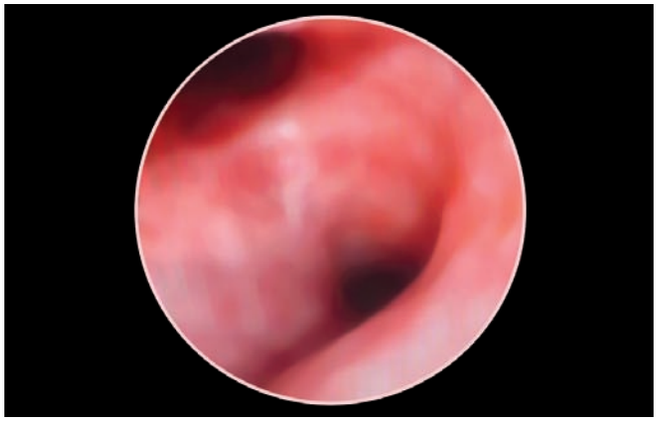

Fig. 17.3: Wide main carina

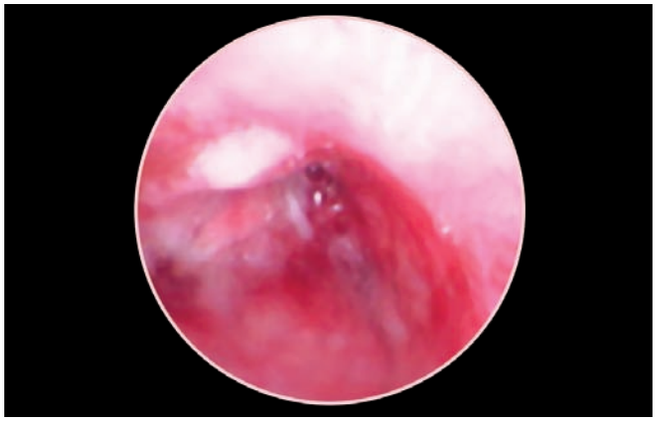

Fig. 17.4: Tumor covered with necrotic slough obstructing the left main bronchus

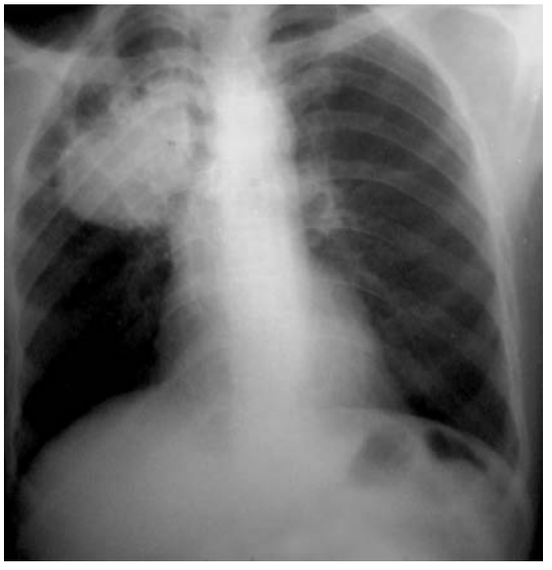

Fig. 17.5: Chest X-ray showing rounded opacity in right lung

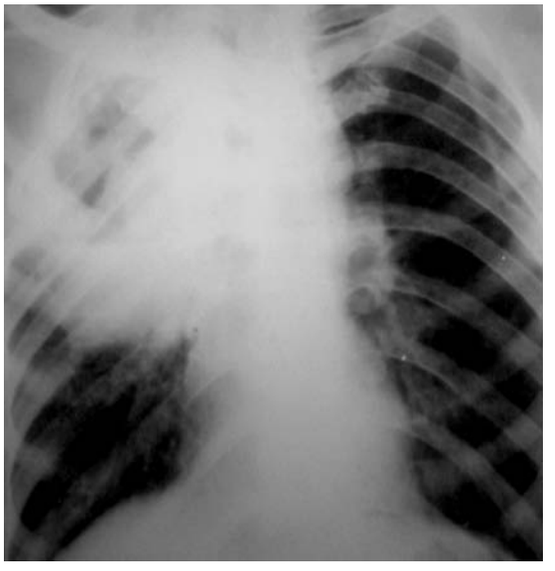

Fig. 17.6: Chest X-ray showing mass increased in size with cavitation

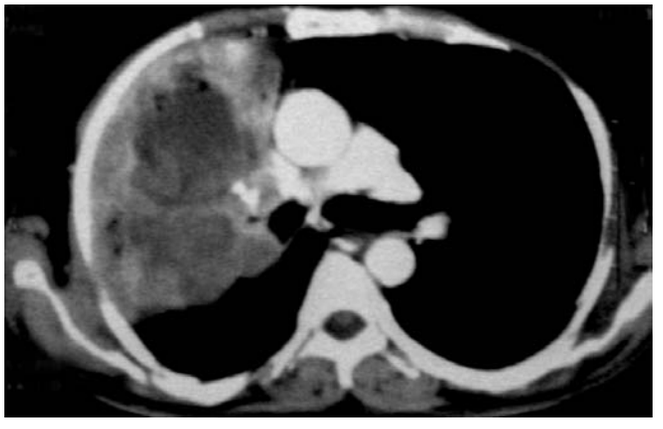

Fig. 17.7: CT thorax heterogeneous mass with large area of necrosis in right lung

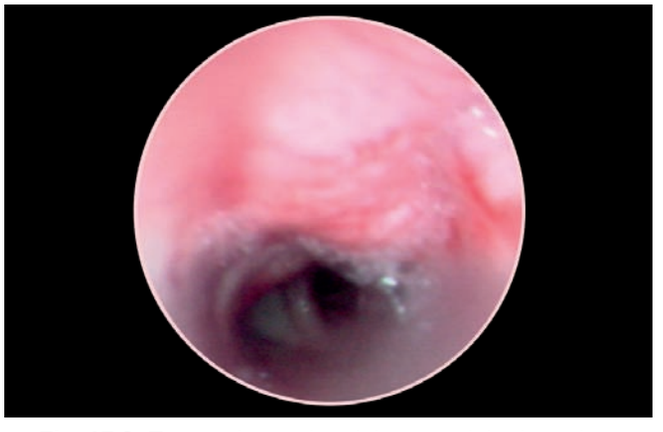

Fig. 17.8: Tumor obstructing right upper lobe bronchus

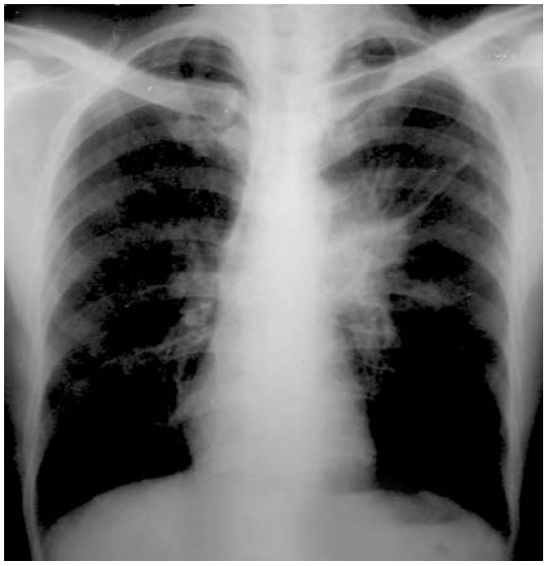

Fig. 17.9: Chest X-ray showing left parahilar mass

Fig. 17.10: CT thorax showing mass involving left main bronchus

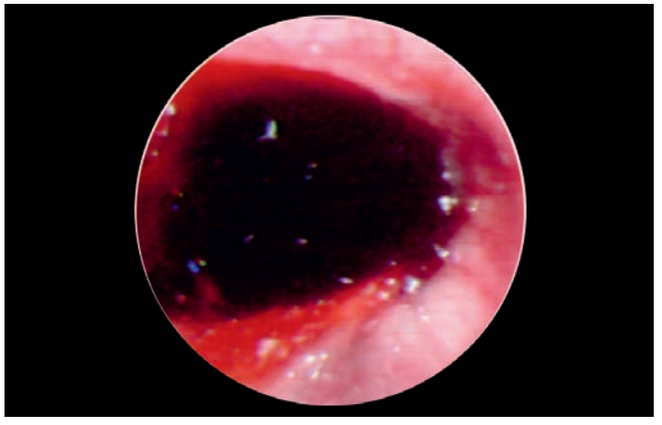

Fig. 17.11: Blood clot filled in left main bronchus

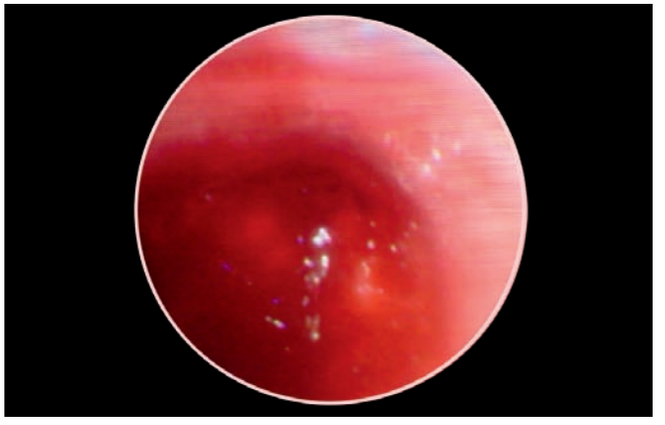

Fig. 17.12: Tumor arising from medial wall of left main bronchus

CASE 19: SQUAMOUS CELL CARCINOMA IN A 71-YEAR-OLD MALE

This patient, cigarette smoker (20 cigarettes/day for last 50 years) and known case of COPD for last 8 years, presented with recurrent hemoptysis (streaking) and loss of appetite for last 4 months. Fiberoptic bronchoscopy showed tumor obstructing anterior segment of left upper lobe with thick and edematous adjacent tertiary carina. Histopathology of endobronchial forceps biopsy was consistent with squamous cell carcinoma (Figs 17.13 to 17.16).

CASE 20: SQUAMOUS CELL CARCINOMA IN A 52-YEAR-OLD MALE

This patient, bidi smoker (20 bidis/day for last 25 years) and known case of COPD for last 3 years, presented with cough and recurrent hemoptysis and loss of appetite for last 2 years and had been misdiagnosed as pulmonary tuberculosis and has taken antitubercular treatment from different doctors in different combinations without any response. Fiberoptic bronchoscopy showed tumor obstructing the left main bronchus 2.5 cm away from main

Fig. 17.13: Chest X-ray showing mass in the left lung

Fig. 17.14: CT thorax showing mass in the left lung

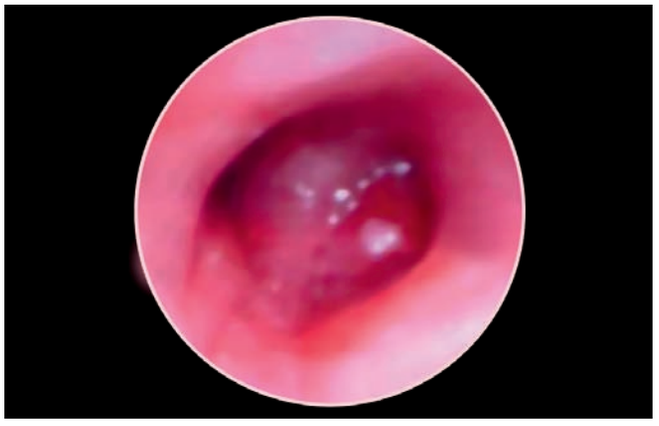

Fig. 17.15: Growth in anterior segment of the left upper lobe with adjacent thick and edematous carina

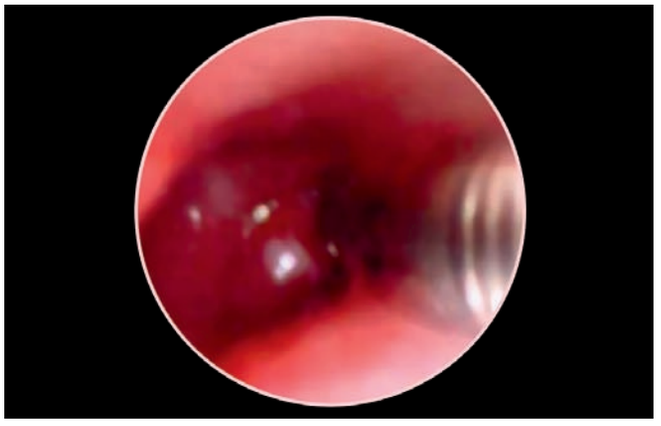

Fig. 17.16: Endobronchial forceps biopsy being taken

carina. Histopathology of endobronchial biopsy of the tumor showed squamous cell carcinoma (Figs 17.17 to 17.20).

CASE 21: SQUAMOUS CELL CARCINOMA IN A 60-YEAR-OLD MALE

This patient, bidi smoker (25 bidis/day for last 30 years) presented with fever, chest pain, weight loss and recurrent hemoptysis for last 6 months. Fiberoptic bronchoscopy showed tumor covered with necrotic slough in left main bronchus. Histopathology of endobronchial and brush biopsy of the tumor showed squamous cell carcinoma (Figs 17.21 to 17.24).

CASE 22: SQUAMOUS CELL CARCINOMA IN A 50-YEAR-OLD MALE

This patient, bidi smoker (15 bidis/day for last 30 years) and known case of COPD for last 5 years, presented with recurrent hemoptysis and loss of appetite and loss of weight for last 6 months. He had been wrongly diagnosed as pulmonary tuberculosis and prescribed antitubercular treatment for 3 months without any response. Fiberoptic bronchoscopy showed irregular tumor arising from lateral wall of left main bronchus, just before its bifurcation. Histopathology of endobronchial biopsy and brush biopsy and cytopathology of bronchial aspirate were consistent with squamous cell carcinoma (Figs 17.25 to 17.28).

Fig. 17.17: Chest X-ray showing collapse of left lung

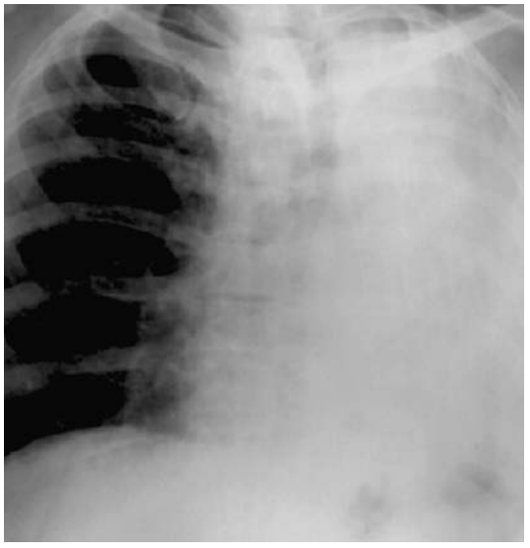

Fig. 17.18: Chest X-ray showing collapse of left lung close view

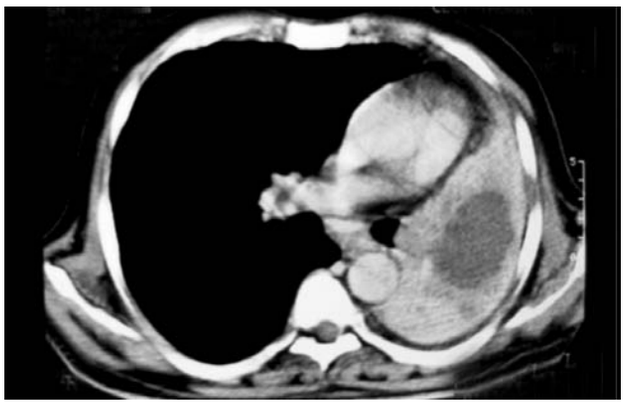

Fig. 17.19: CT thorax showing mass in left lung with necrosis

Fig. 17.20: Tumor with flakes of pus obstructing left main bronchus

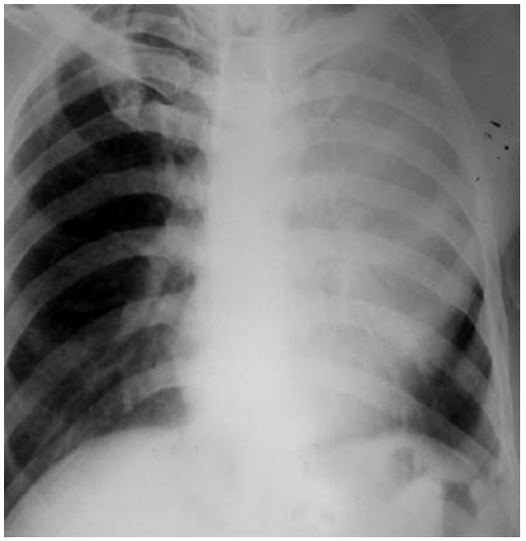

Fig. 17.21: Mass in the left lung

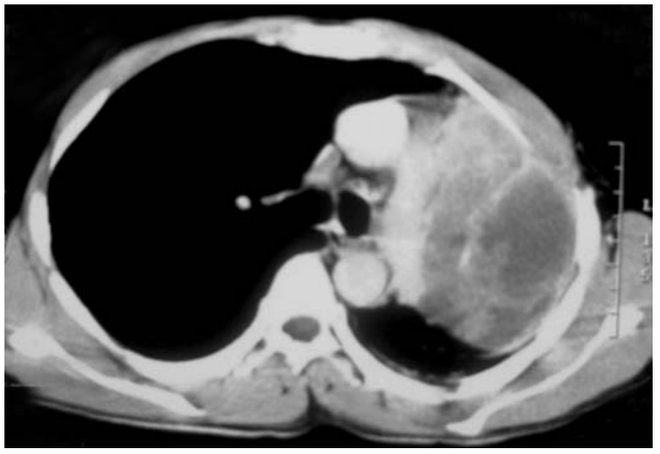

Fig. 17.22: Mass in the left lung with necrotic areas

Fig. 17.23: Mass covered with necrotic slough in left main bronchus

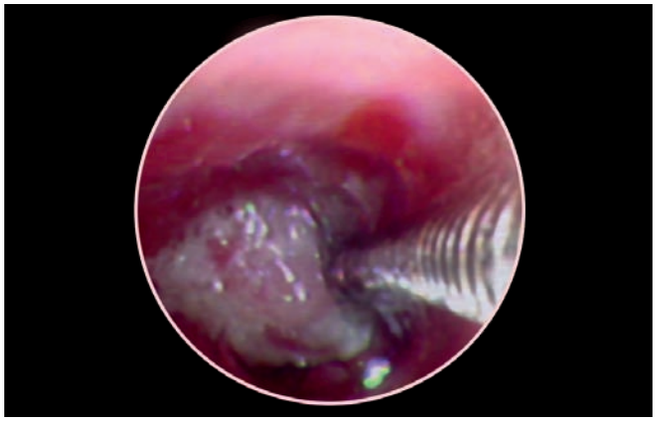

Fig. 17.24: Endobronchial biopsy of the tumor

CASE 23: SQUAMOUS CELL CARCINOMA IN A 50-YEAR-OLD MALE

This patient, nonsmoker presented with low grade fever, chest pain, loss of appetite and hoarseness of voice for last 4 months. Chest X-ray showed thick-walled cavity in the left upper zone and misdiagnosed as pulmonary tuberculosis and was treated for tuberculosis for 3 months without any response. Fiberoptic bronchoscopy showed paralyzed left vocal cord and tumor in the left main bronchus, just before its bifurcation. Histopathology of endobronchial biopsy of the tumor showed squamous cell carcinoma (Figs 17.29 to 17.32).

CASE 24: SQUAMOUS CELL CARCINOMA IN A 50-YEAR-OLD MALE

This patient, bidi smoker (20 bidi/day for last 30 years) presented with cough, loss of appetite and breathlessness for last 1 year. There was a hard lymph node (2 × 2 cm) in left supraclavicular area. Fine needle aspiration cytology of supraclavicular lymph node, showed metastasis from squamous cell carcinoma. Fiberoptic bronchoscopy showed tumor obstructing apicoposterior and anterior segmental openings of left upper lobe. Histopathology of endobronchial and brush biopsy of the tumor showed squamous cell carcinoma (Figs 17.33 to 17.36).

CASE 25: SQUAMOUS CELL CARCINOMA IN A 45-YEAR-OLD FEMALE

This patient, nonsmoker, but having exposure to biomass fuel smoke (cow dung cake and wood were used for cooking) for 20 years, presented with cough for 9 months, chest pain, breathlessness and hemoptysis for last 6 months. Patient had already received 3 months of antitubercular treatment without any response. Fiberoptic bronchoscopy showed irregular growth, which bled on touch in the left main bronchus, just before its bifurcation. Histopathology of endobronchial and brush biopsy of the growth showed squamous cell carcinoma (Figs 17.37 to 17.40) .

CASE 26: SQUAMOUS CELL CARCINOMA IN A 56-YEAR-OLD MALE

This patient, bidi smoker (10 bidi/day for 35 years) presented with cough, chest pain, breathlessness and recurrent hemoptysis (streaking) for last 10 months. Patient had been misdiagnosed as pulmonary tuberculosis and had received 6 months of antitubercular treatment without any response. Fiberoptic bronchoscopy showed irregular growth covered with necrotic slough obstructing the left main bronchus. Histopathology of endobronchial and brush biopsy of the growth showed squamous cell carcinoma (Figs 17.41 to 17.44).

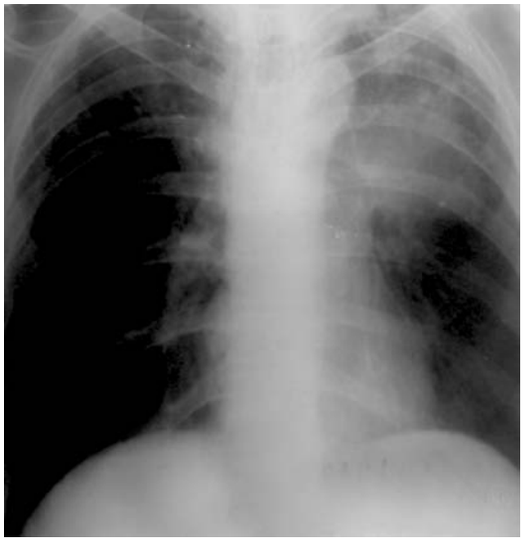

Fig. 17.25: Chest X-ray showing mass in left lung

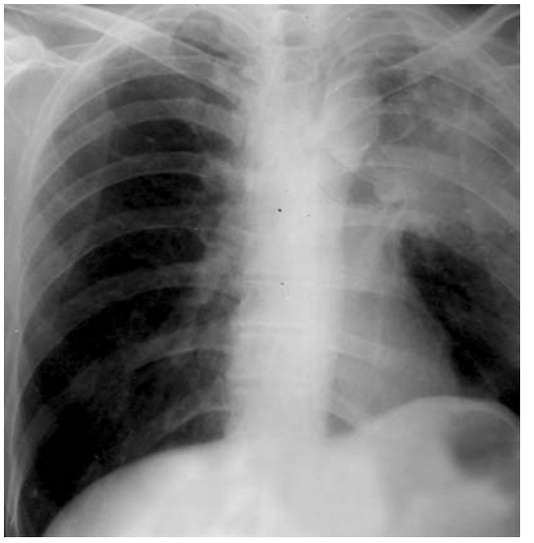

Fig. 17.26: Chest X-ray showing that size of mass has increased

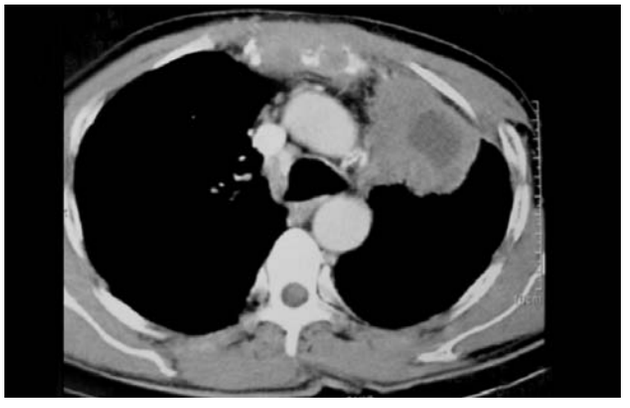

Fig. 17.27: CT thorax showing mass with necrosis in left lung

Fig. 17.28: Growth arising out of lateral wall of the left main bronchus, just before its bifurcation

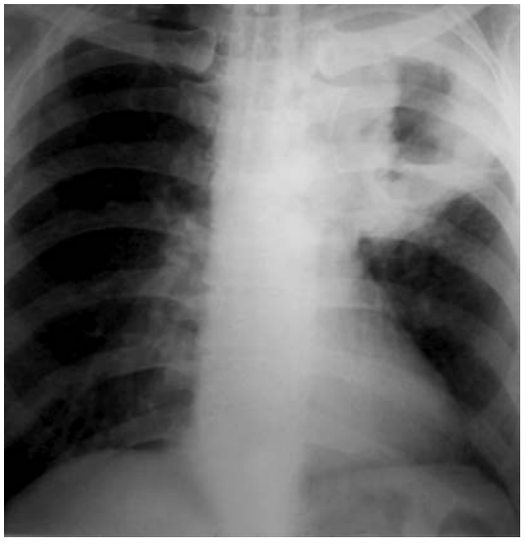

Fig. 17.29: Chest X-ray showing cavitating mass in the left lung

Fig. 17.30: Chest X-ray showing increased size of the mass

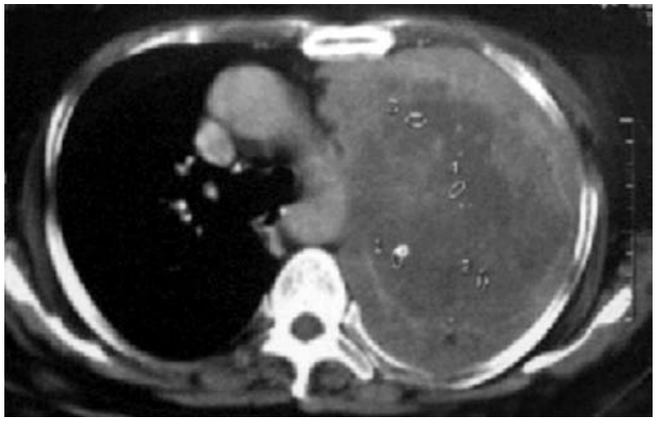

Fig. 17.31: Chest X-ray showing mass with massive necrosis in left lung

Fig. 17.32: Tumor obstructing left main bronchus just before its bifurcation

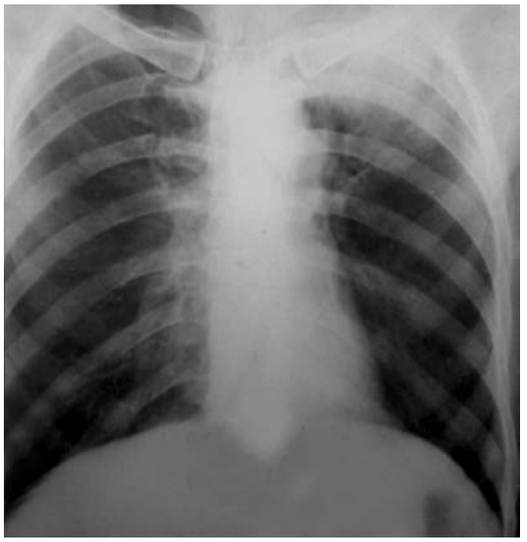

Fig. 17.33: Chest X-ray showing radio-opaque shadow in the left lung

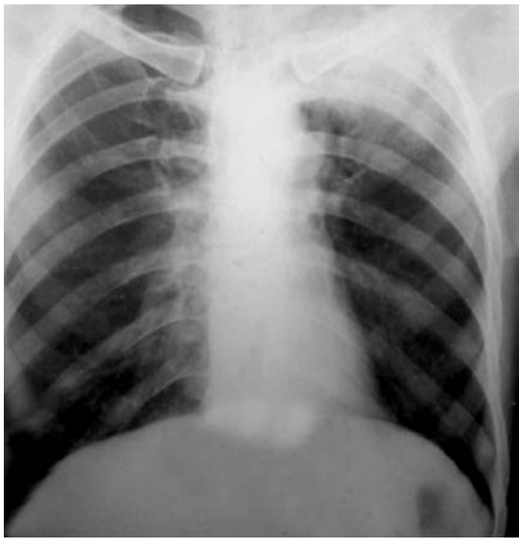

Fig. 17.34: Chest X-ray showing increase in size of radio-opaque shadow in the left lung

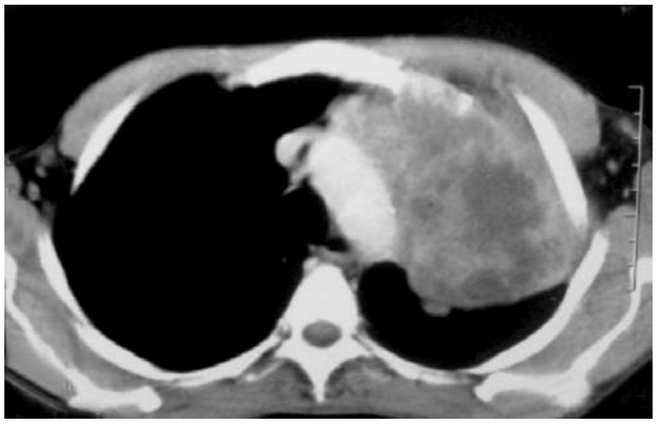

Fig. 17.35: CT thorax showing intrathoracic mass with necrosis

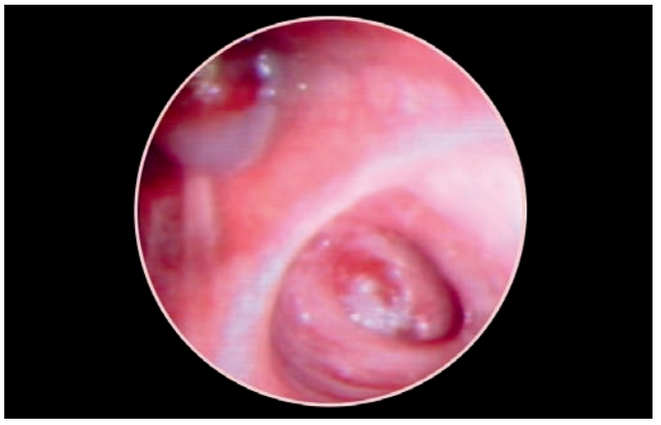

Fig. 17.36: Tumor in apicoposterior and anterior segment of left upper lobe

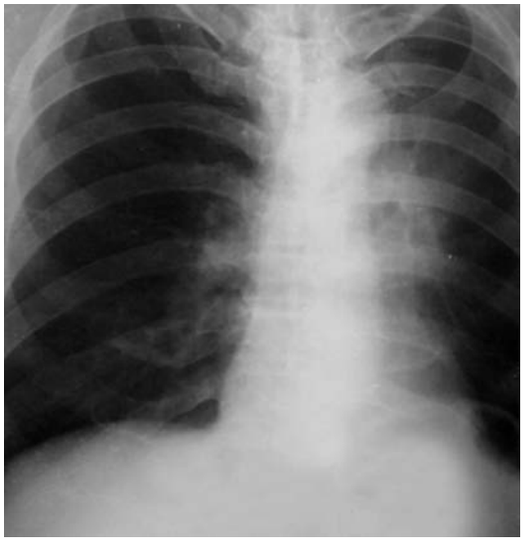

Fig. 17.37: Chest X-ray showing mass in the parahilar area of left lung

Fig. 17.38: Chest X-ray showing collapse with effusion on left side

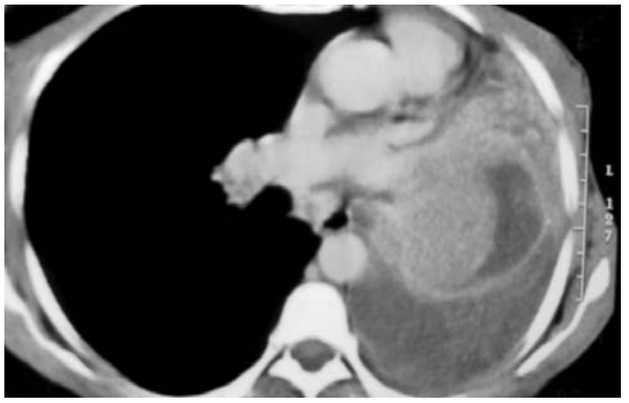

Fig. 17.39: CT thorax showing mass with necrosis with pleural effusion

Fig. 17.40: Irregular growth in left main bronchus, just before its bifurcation

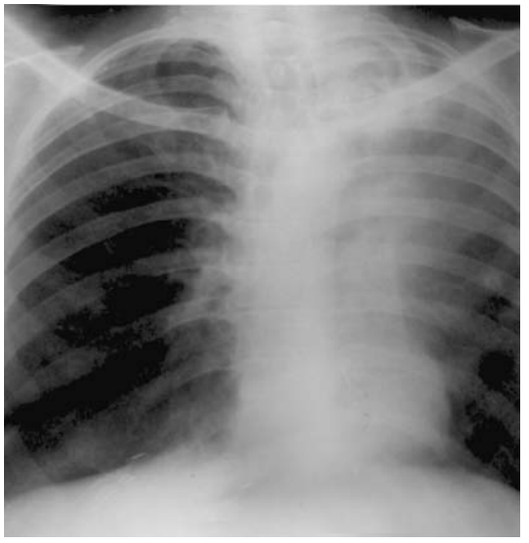

Fig. 17.41: Chest X-ray showing radio-opaque shadow in the left upper zone

Fig. 17.42: Chest X-ray showing collapse of left lung

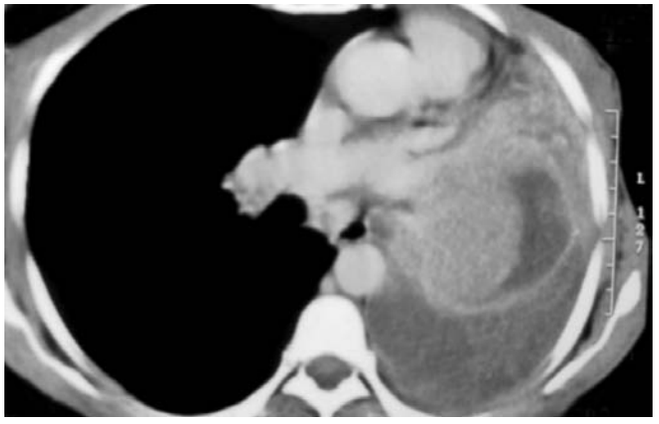

Fig. 17.43: CT thorax showing mass in left lung

Fig. 17.44: Irregular growth covered with necrotic slough

CASE 27: SQUAMOUS CELL CARCINOMA IN A 53-YEAR-OLD MALE

This patient, bidi and cigarette smoker (30/day for 30 years), a known case of COPD for last 12 years, presented with recurrent streaking, chest pain, loss of appetite and change in voice for last 1 month. There was a postauricular hard lymph node (2 × 2 cm) on left side. Fine needle aspiration cytology of post-auricular lymph node showed metastasis from squamous cell carcinoma. 300 cc of pleural fluid was aspirated from left side and which was negative for malignant cells. Fiberoptic bronchoscopy showed irregular growth at carina extending into the medial wall of the right main bronchus. Left main bronchus was also infiltrated with tumor till its bifurcation and secondary carina was also involved. Histopathology of endobronchial and brush biopsy of the growth showed squamous cell carcinoma (Figs 17.45 to 17.52).

CASE 28: SQUAMOUS CELL CARCINOMA IN A 65-YEAR-OLD MALE

This patient, bidi and ganja smoker (40/day for 30 years), a known case of COPD for last 3 years presented with recurrent streaking, pain over back, loss of appetite and change in voice for last 1 year. Computed tomography (CT) thorax shows mass in the left lung with osteolytic secondaries in vertebral body. Fiberoptic bronchoscopy showed growth covered with necrotic slough obstructing left main bronchus, just near the main carina. Histopathology of endobronchial biopsy of the growth showed squamous cell carcinoma (Figs 17.53 to 17.56).

CASE 29: SQUAMOUS CELL CARCINOMA IN A 55-YEAR-OLD MALE

This patient, bidi smoker (30/day for 30 years), a known case of COPD for last 5 years presented with fever, loss of appetite for last 6 months. Patient was wrongly diagnosed as tuberculosis and was given antitubercular treatment for 3 months without any response. Fiberoptic bronchoscopy showed tumor covered with necrotic slough obstructing right main bronchus, just near the main carina. Histopathology of endobronchial and brush biopsy of the tumor showed squamous cell carcinoma (Figs 17.57 to 17.60).

CASE 30: SQUAMOUS CELL CARCINOMA IN A 55-YEAR-OLD MALE

This patient, cigarette smoker (10/day for 25 years), presented with neurological symptoms. CT head showed secondaries. Chest X-ray showed paracardiac shadow and CT thorax showed mass in the right lower lobe. Fiberoptic bronchoscopy showed irregular growth obstructing medial basal segment of right lower lobe. Histopathology of endobronchial biopsy of the growth showed squamous cell carcinoma (Figs 17.61 to 17.64).

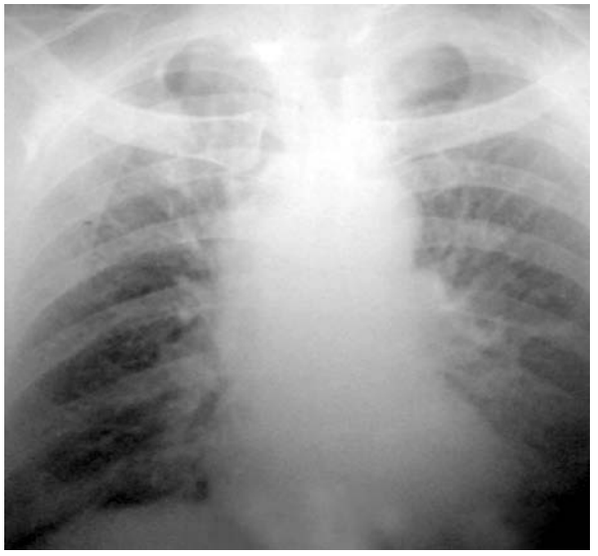

Fig. 17.45: Apparently normal looking chest X-ray

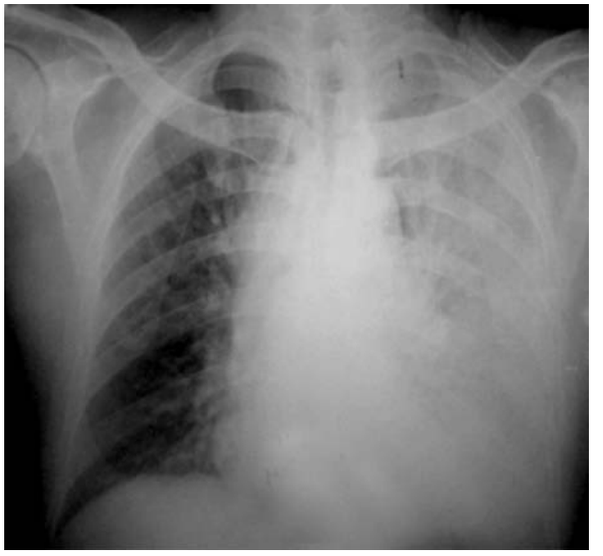

Fig. 17.46: Chest X-ray showing radio-opaque shadow in the left lung

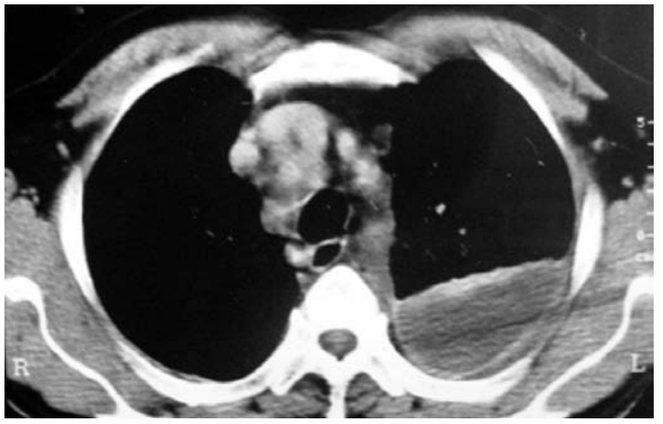

Fig. 17.47: CT thorax showing pleural effusion on left side

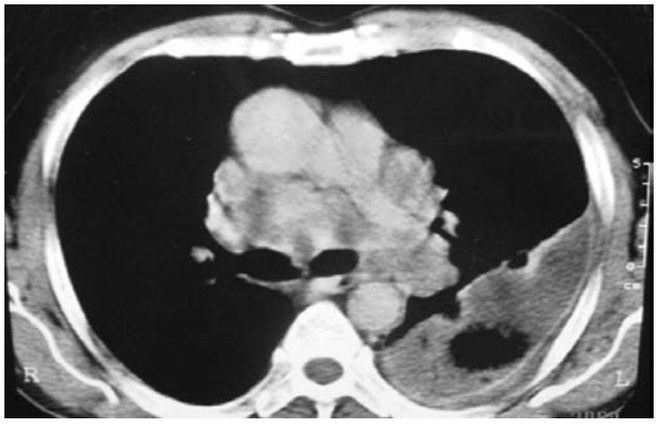

Fig. 17.48: CT thorax showing growth involving mediastinum with lymph nodes

Fig. 17.49: Multinodular growth at carina

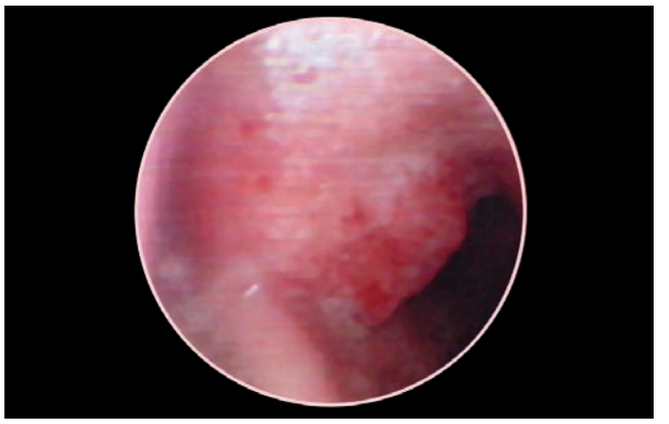

Fig. 17.50: Growth in the medial wall of the right main bronchus

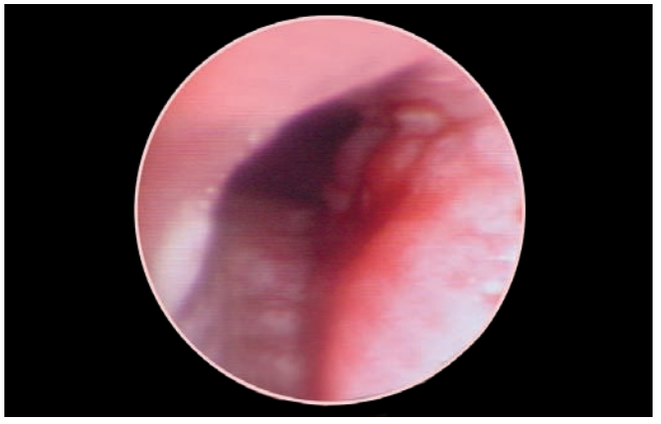

Fig. 17.51: Involvement of left main bronchus by growth

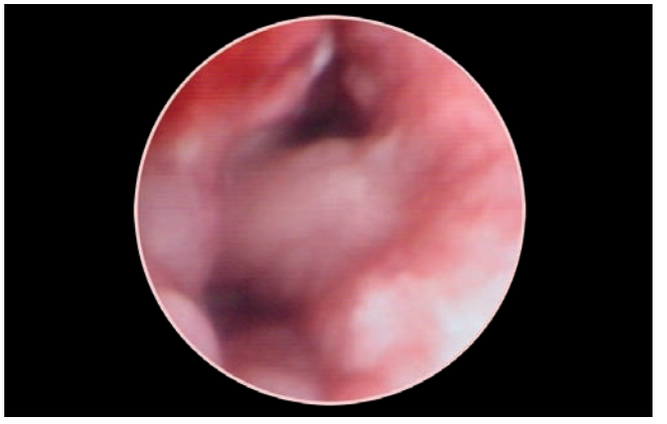

Fig. 17.52: Involvement of secondary carina at bifurcation of left main bronchus

Fig. 17.53: Chest X-ray showing collapse of left lung

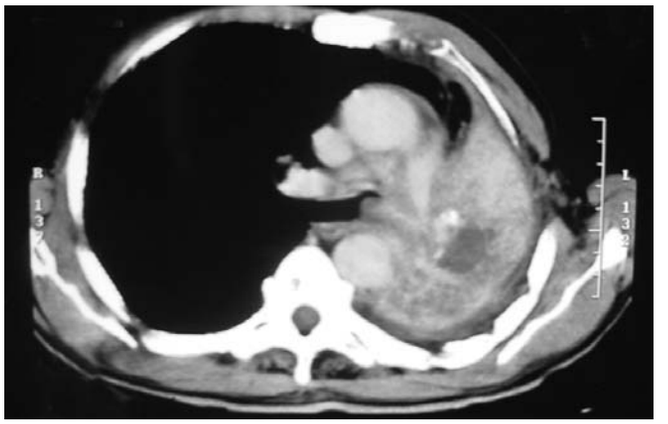

Fig. 17.54: CT thorax showing mass with necrosis in left lung

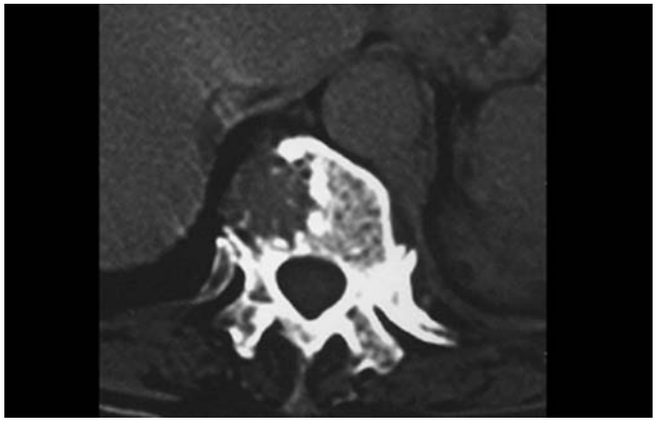

Fig. 17.55: CT thorax showing osteolytic secondaries in vertebra

Fig. 17.56: Tumor covered with necrotic slough obstructing left main bronchus

Fig. 17.57: Chest X-ray showing obstructive pneumonitis in right upper zone

Fig. 17.58: Chest X-ray showing obstructive pneumonitis with mass in right lung

Fig. 17.59: Chest X-ray showing collapse of right lung

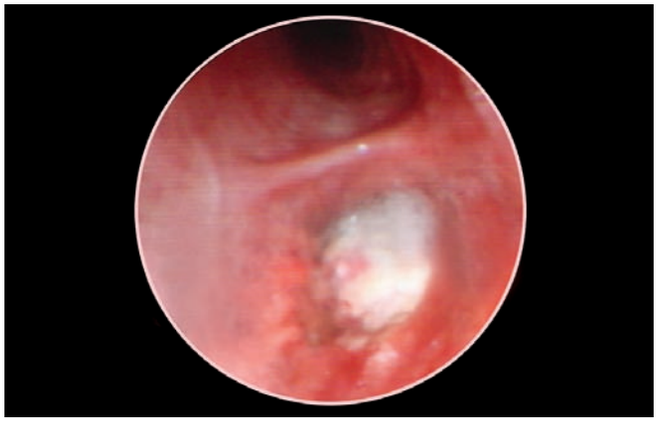

Fig. 17.60: Tumor covered with necrotic slough obstructing right main bronchus near main carina

Fig. 17.61: Chest X-ray showing paracardiac shadow in the right lung

Fig. 17.62: CT thorax showing mass in the right lung

Fig. 17.63: CT head showing secondaries in the brain

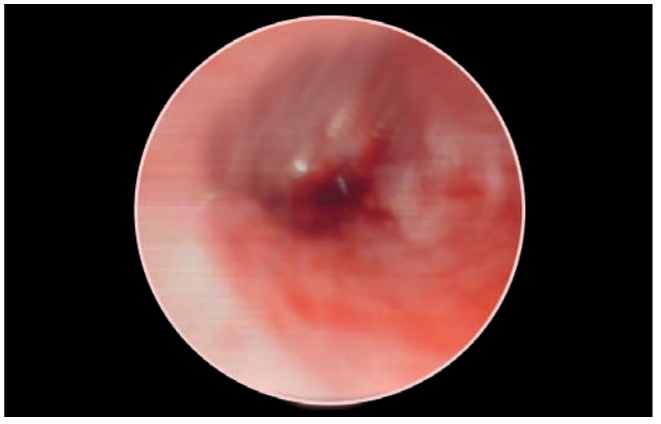

Fig. 17.64: Irregular growth obstructing medial basal segment of right lower lobe

CASE 31: ADENOCARCINOMA IN A 53-YEAR-OLD MALE

This patient, cigarette smoker (15 cigarette/day for 30 years), presented with chest pain on right side and recurrent pleural effusion on the right side for last 6 months. He had received antitubercular treatment for 6 months without any response. Fiberoptic bronchoscopy showed widening and infiltration of secondary carina, near right upper lobe bronchus with narrowed right upper lobe bronchus. Middle lobe opening was also narrowed. Pleural fluid cytology was positive for malignant cells. Histopathology of endobronchial biopsy from secondary carina showed adenocarcinoma. CT thorax also showed multiple secondaries (Figs 17.65 to 17.72).

CASE 32: SQUAMOUS CELL CARCINOMA IN A 47-YEAR-OLD MALE

This patient, bidi smoker (20 bidi/day for 30 years) known case of COPD, presented with chest pain for last 3 months. Hard left supraclavicular lymph node was palpable. Fiberoptic bronchoscopy showed widening and infiltration of main carina and left main bronchus. Cytopathology of transcarinal needle aspiration and histopathology of endobronchial biopsy, showed squamous cell carcinoma (Figs 17.73 to 17.80).

CASE 33: SQUAMOUS CELL CARCINOMA IN A 58-YEAR-OLD MALE

This patient, bidi smoker (15 bidi/day for 40 years) presented with cough, recurrent hemoptysis and loss of appetite for last 4 months. He was prescribed antitubercular treatment for 3 months without any response. Fiberoptic bronchoscopy showed multinodular growth covered with necrotic slough, obstructing the left main bronchus. Histopathology of endobronchial and brush biopsy from tumor showed squamous cell carcinoma (Figs 17.81 to 17.86).

CASE 34: ADENOCARCINOMA IN A 40-YEAR-OLD MALE

This patient, nonsmoker presented with cough, loss of appetite for last 7 months and hemoptysis (streaking) for last 2 months and he was wrongly prescribed antitubercular treatment for 4 months without any response. Fiberoptic bronchoscopy showed multinodular growth at carina. Histopathology of endobroncial biopsy from tumor was consistent with adenocarcinoma. CT head showed secondaries in the brain (Figs 17.87 to 17.94).

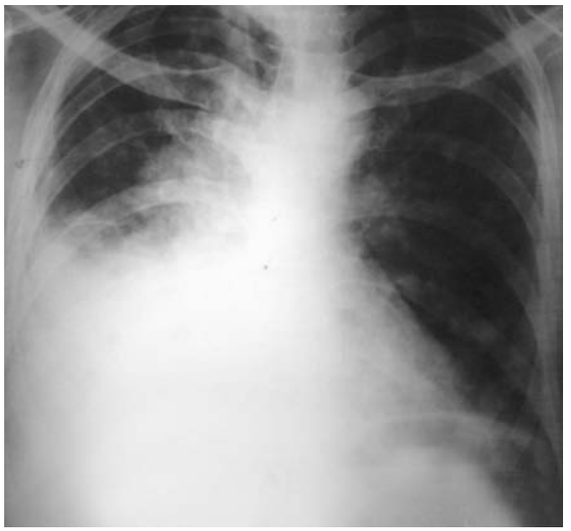

Fig. 17.65: Chest X-ray showing parahilar mass in the right lung with pleural effusion

Fig. 17.66: Chest X-ray showing parahilar mass in the right lung with multiple secondaries

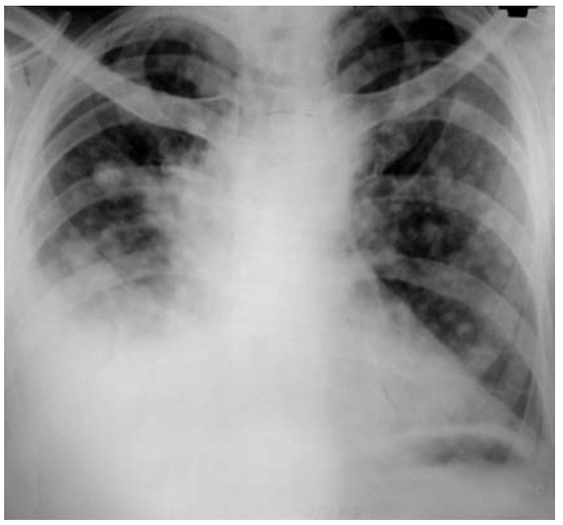

Fig. 17.67: Chest X-ray showing pleural effusion on right side has increased

Fig. 17.68: CT thorax showing mass in the right lung with pleural effusion

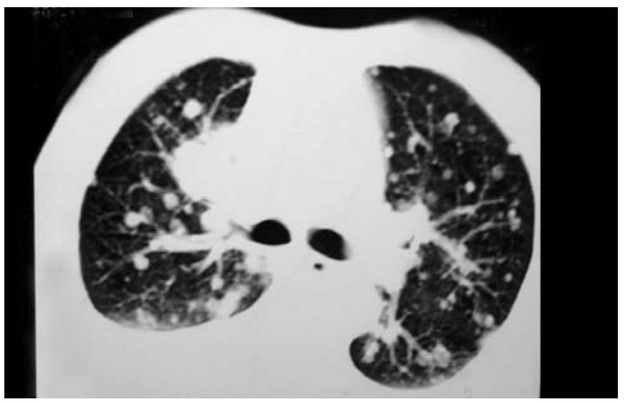

Fig. 17.69: CT thorax showing secondaries in lungs

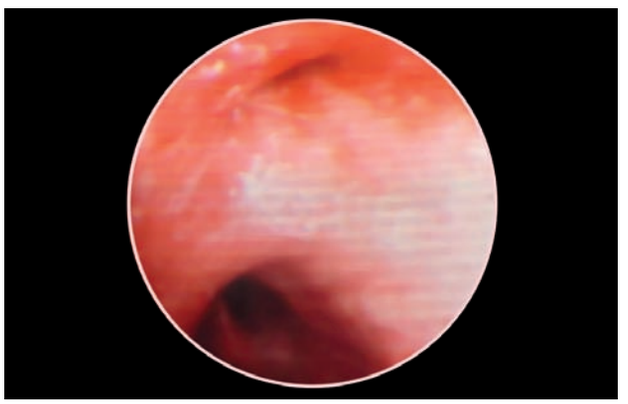

Fig. 17.70: Secondary carina near right upper lobe is wide and infiltrated obliterating right upper lobe bronchus

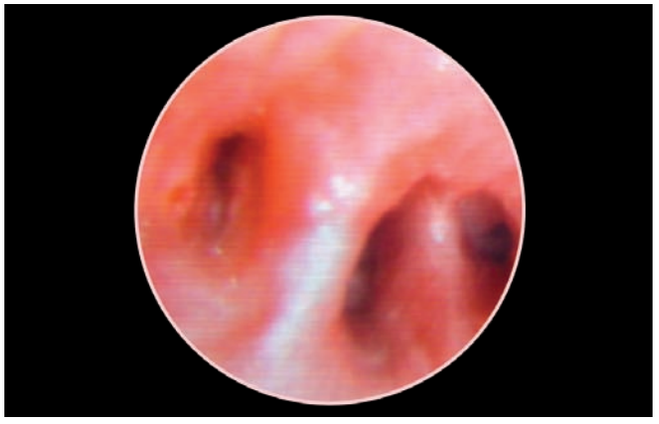

Fig. 17.71: Narrowed middle lobe bronchus

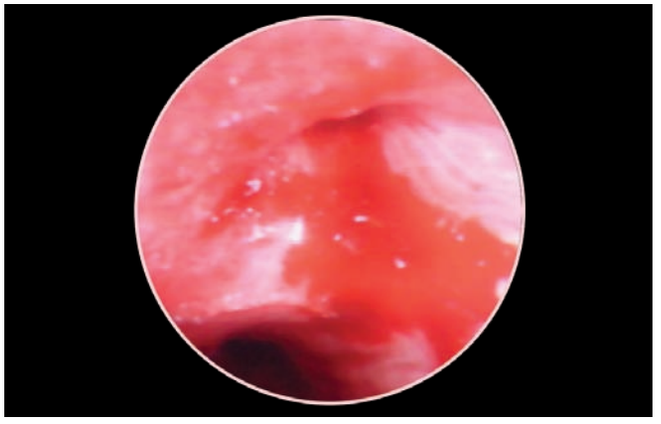

Fig. 17.72: Bleeding after endobronchial biopsy

Fig. 17.73: Chest X-ray showing mediastinal widening

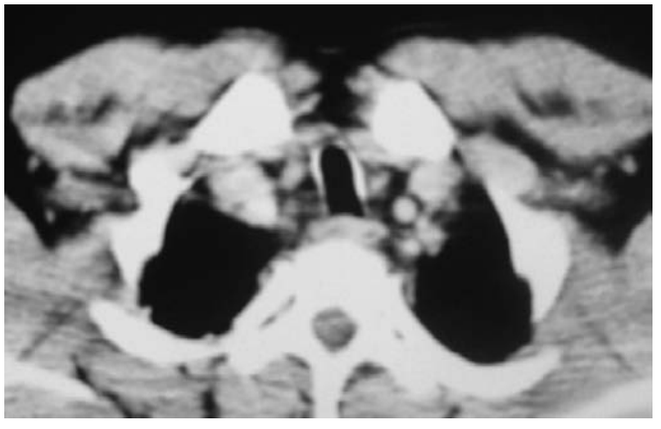

Fig. 17.74: CT thorax showing saber-sheath trachea

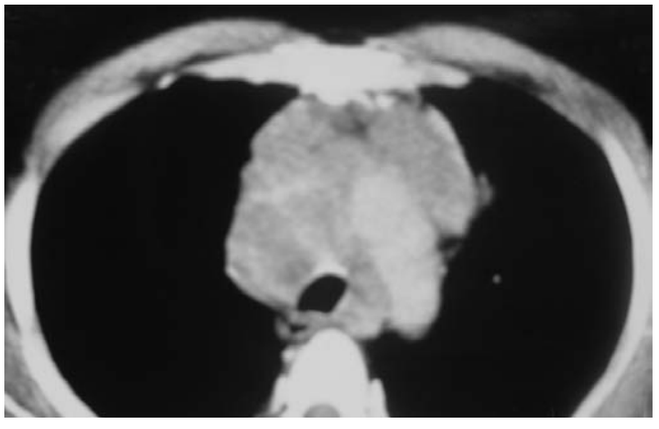

Fig. 17.75: CT thorax showing mediastinal mass

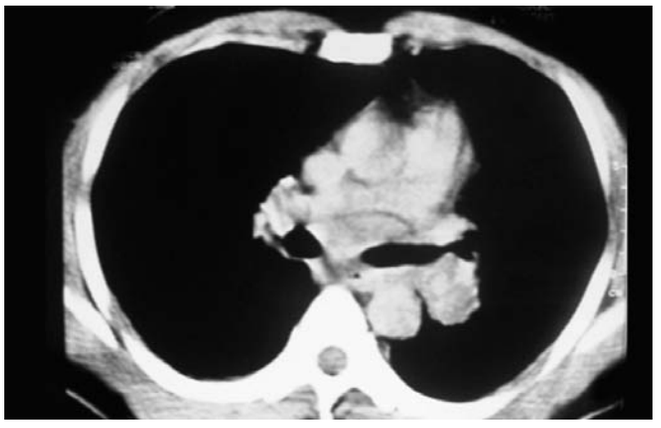

Fig. 17.76: CT thorax showing tumor involving main carina and left main bronchus

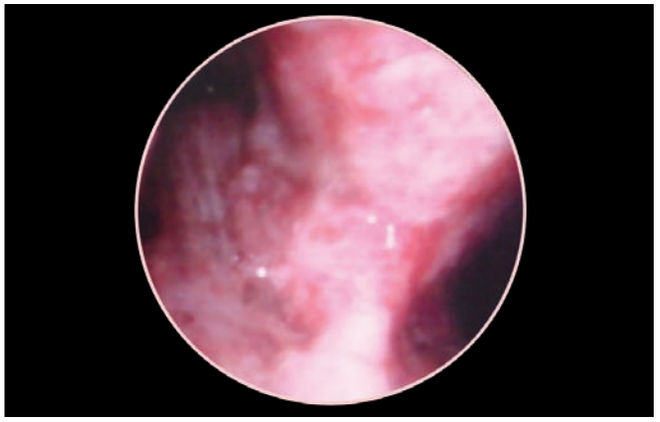

Fig. 17.77: Wide and infiltrated main carina

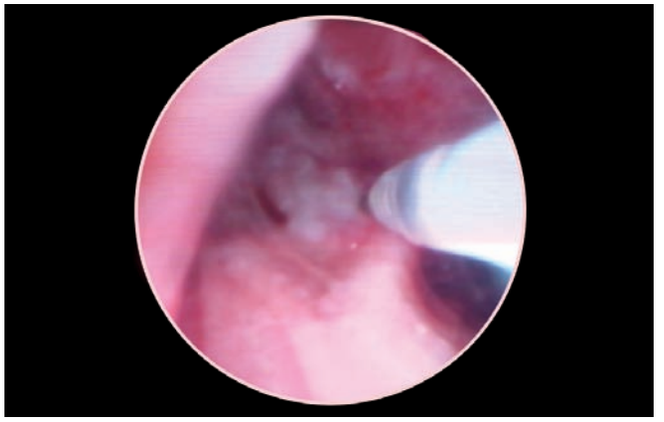

Fig. 17.78: Transcarinal needle aspiration

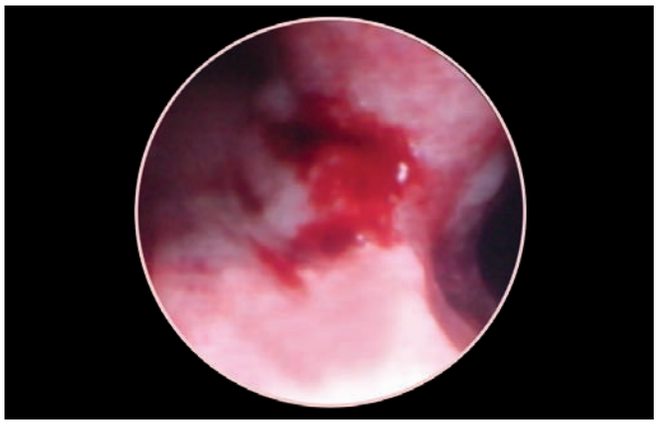

Fig. 17.79: Bleeding after transcarinal needle aspiration

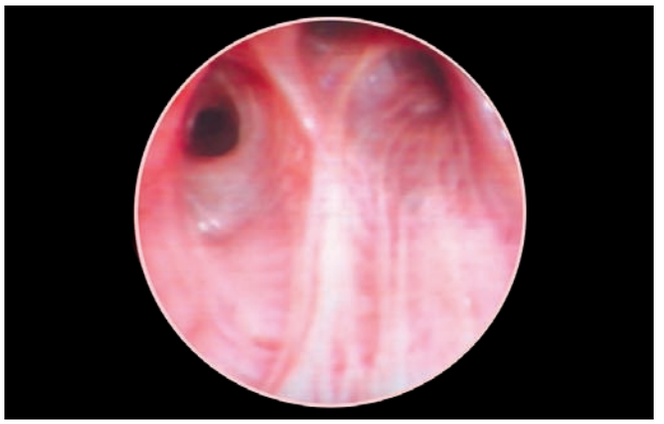

Fig. 17.80: Evidence of chronic bronchitis

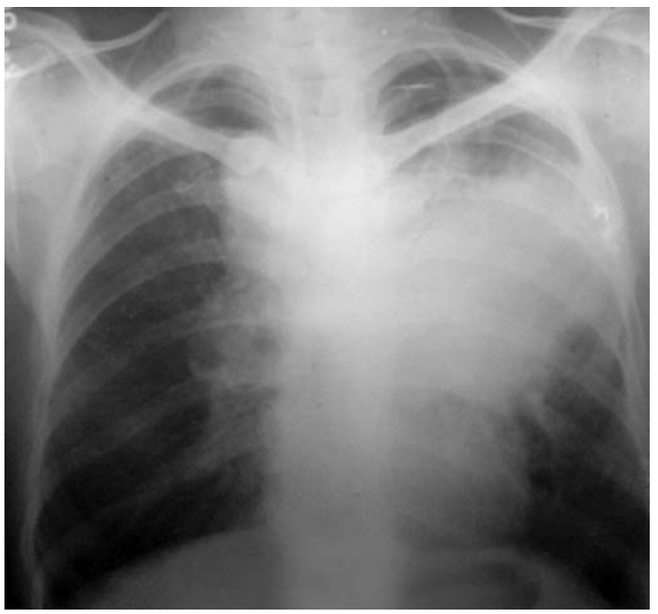

Fig. 17.81: Chest X-ray showing obstructive pneumonitis in left lung with mediastinal lymph nodes

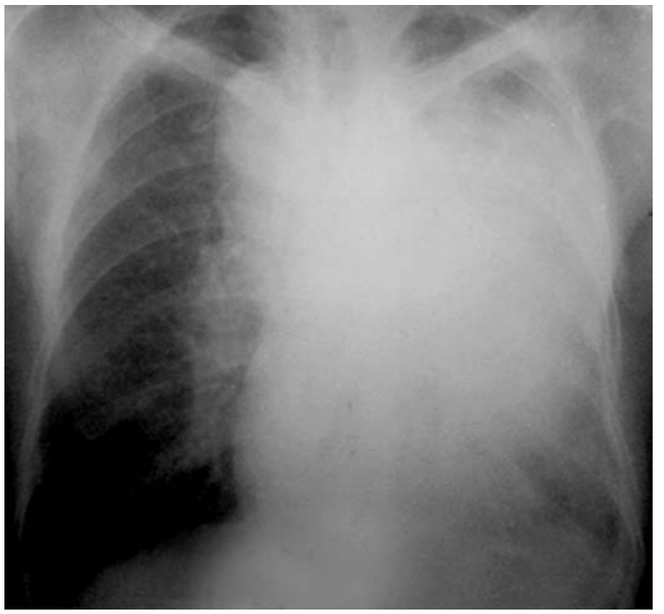

Fig. 17.82: Obstructive pneumonitis in left lung with increased size of mediastinal lymph nodes

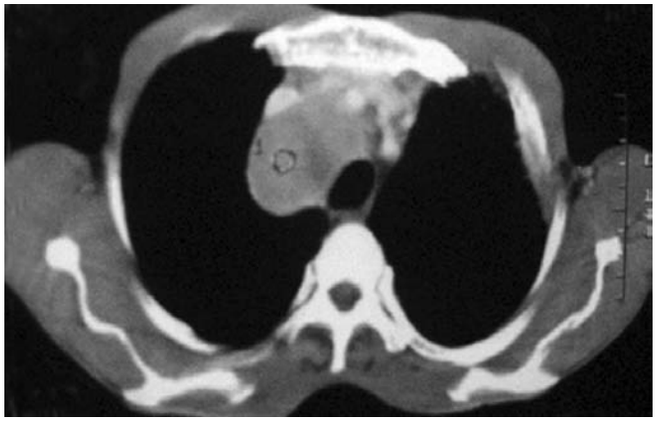

Fig. 17.83: CT thorax showing right tracheobronchial lymph node

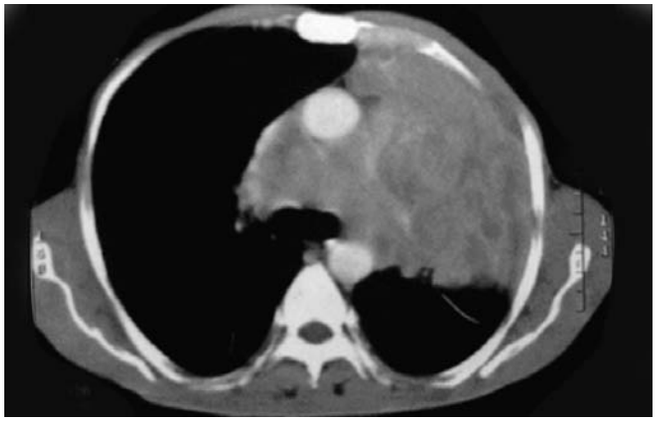

Fig. 17.84: CT thorax showing mass in left lung

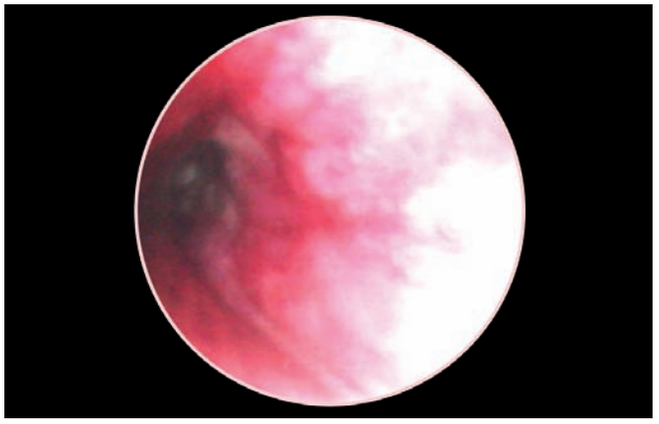

Fig. 17.85: Multinodular growth at left main bronchus

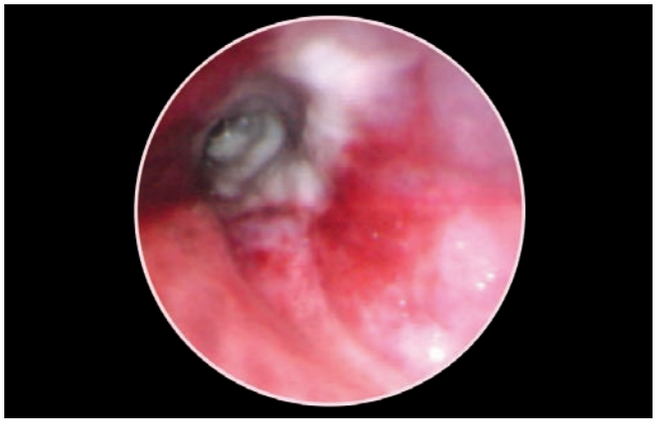

Fig. 17.86: Multinodular growth with necrotic slough

Fig. 17.87: Normal looking chest X-ray

Fig. 17.88: Chest X-ray showing obstructive pneumonitis on right side

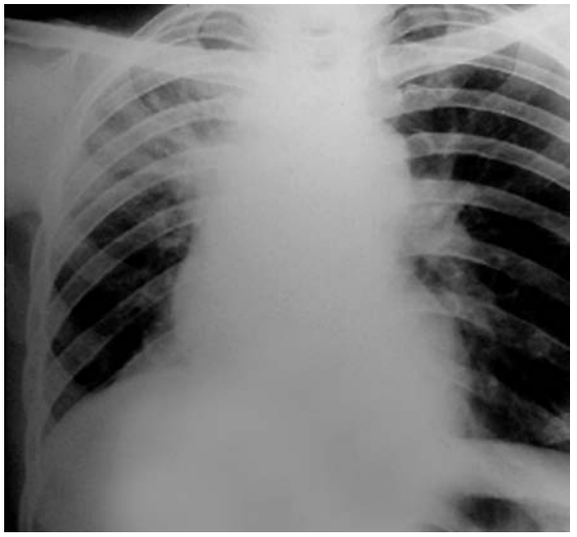

Fig. 17.89: Chest X-ray showing mass in right lung

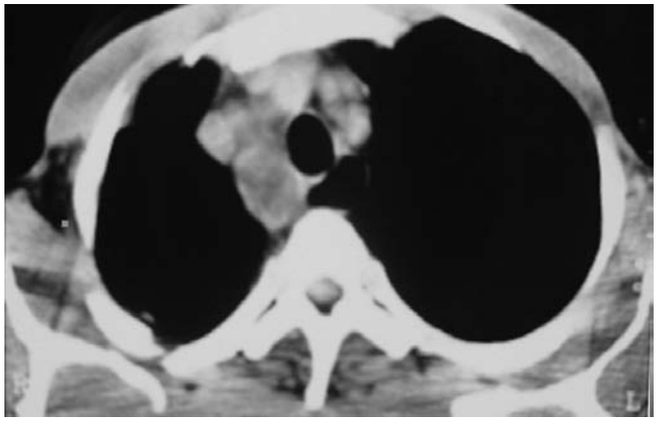

Fig. 17.90: CT thorax showing mass in right lung

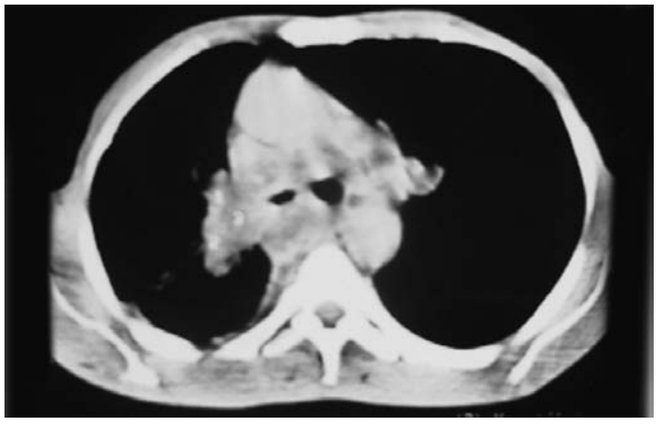

Fig. 17.91: CT thorax showing mass in right lung indenting carina

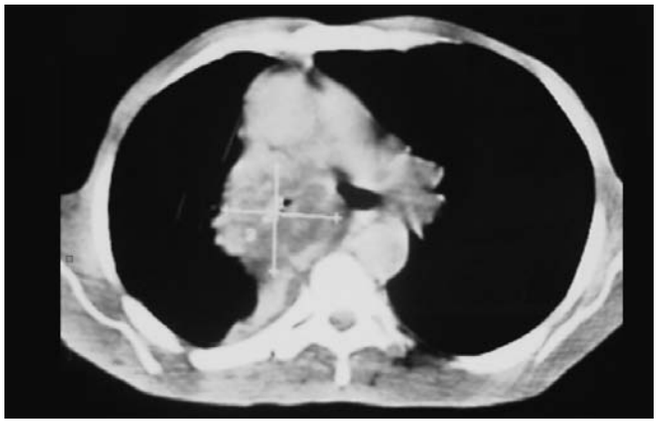

Fig. 17.92: CT thorax showing mass in the right lung

Fig. 17.93: CT head showing secondaries in brain

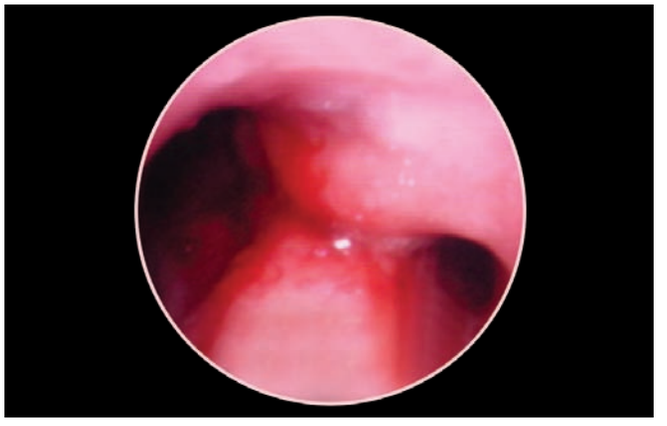

Fig. 17.94: Growth involving main carina

CASE 35: SQUAMOUS CELL CARCINOMA IN A 60-YEAR-OLD MALE

This patient, bidi smoker (30 bidi/day for 30 years) known case of COPD presented with recurrent hemoptysis (streaking) for last 2 months. Pleural fluid was aspirated from right pleural space. Fiberoptic bronchoscopy showed fungating mass obstructing right main bronchus. Histopathology of endobronchial biopsy was consistent with squamous cell carcinoma (Figs 17.95 to 17.100).

Fig. 17.95: Chest X-ray showing pleural effusion with central mediastinum

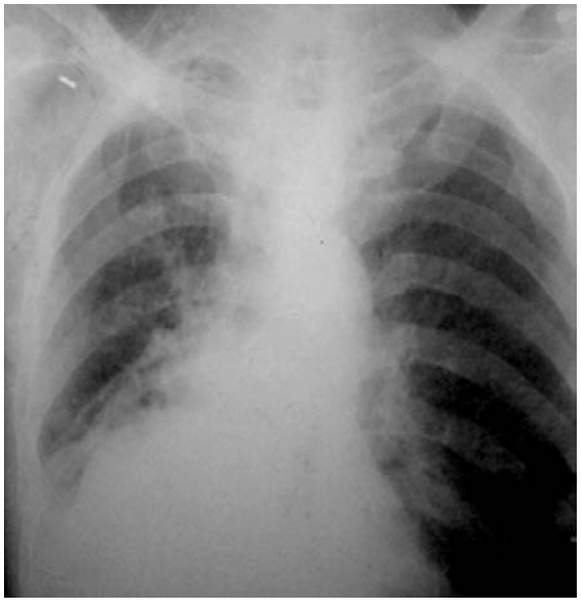

Fig. 17.96: Chest X-ray following pleural aspiration

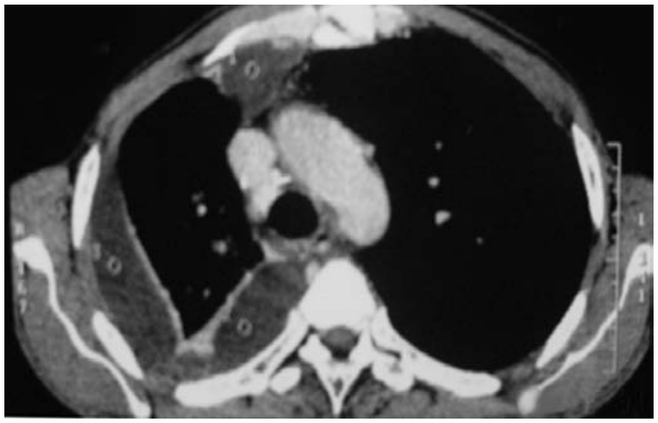

Fig. 17.97: CT thorax showing multiple pockets of fluid

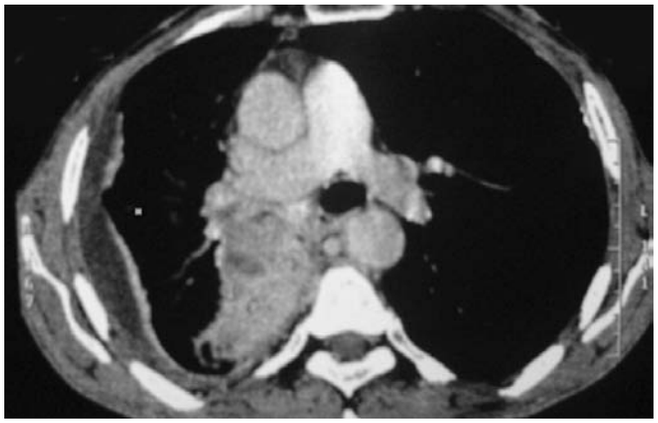

Fig. 17.98: CT thorax showing mass with pleural effusion

CASE 36: LARGE CELL CARCINOMA IN A 70-YEAR-OLD MALE

This patient, bidi smoker (20 bidi/day for 30 years) presented with cough, breathlessness, loss of appetite and weight for last 4 months. He was misdiagnosed as tuberculosis and prescribed antitubercular treatment for 5 months, without any response. Fiberoptic bronchoscopy showed tumor covered with necrotic slough in left main bronchus. Histopathology endobroncial and brush biopsy from tumor showed large cell carcinoma (Figs 17.101 to 17.104).

Fig. 17.99: Fungating mass in right main bronchus near main carina

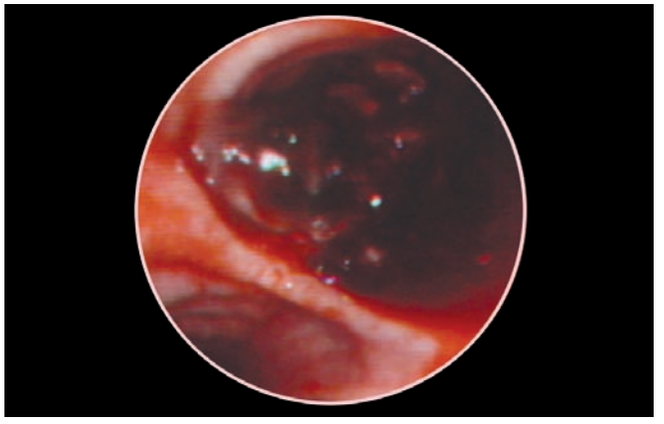

Fig. 17.100: Bleeding seen after endobronchial biopsy

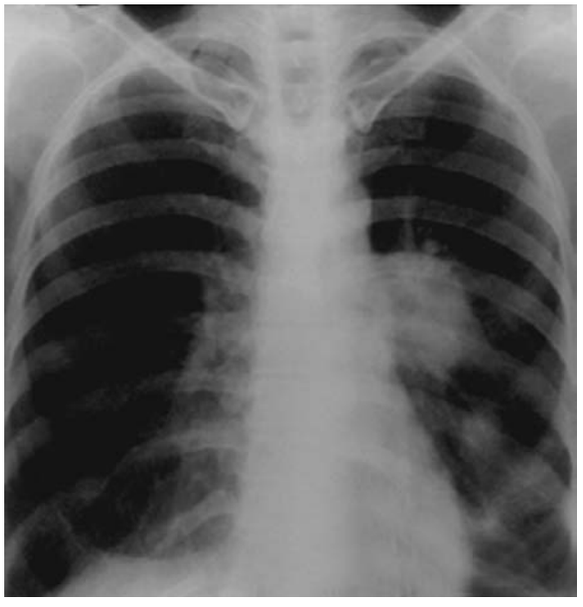

Fig. 17.101: Chest X-ray showing parahilar mass with nodular shadows in left lower zone

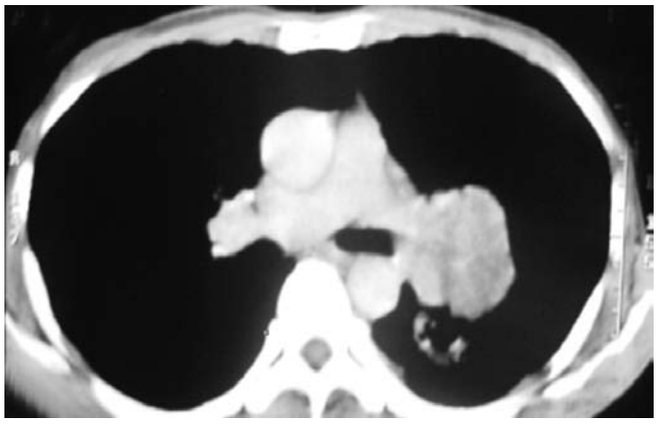

Fig. 17.102: CT thorax showing parahilar mass on left side

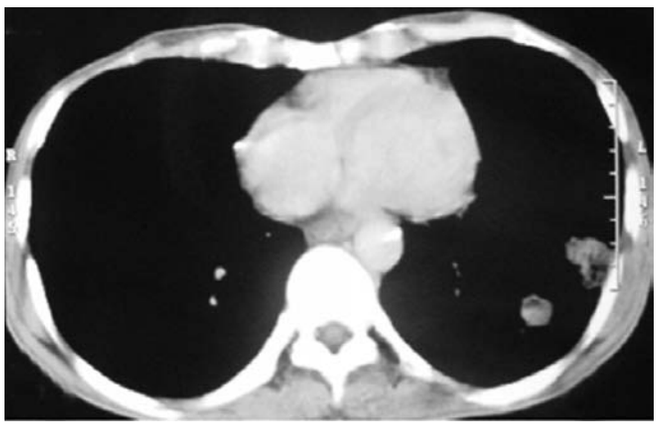

Fig. 17.103: CT thorax showing nodular shadows in left lower lobe

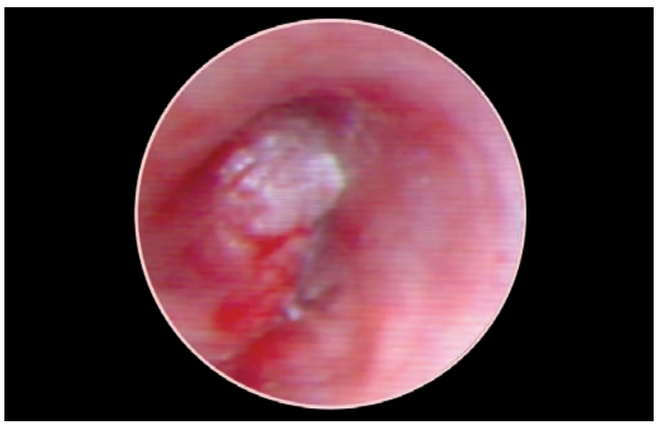

Fig. 17.104: Tumor obstructing left main bronchus

CASE 37: ADENOCARCINOMA IN A 65-YEAR-OLD FEMALE

This patient, nonsmoker presented with cough, chest pain, breathlessness, loss of appetite and weight loss for last 11 months. She was diagnosed as a case of pleural effusion left side and was given antitubercular treatment for 6 months, without any response. Pleural aspiration was done and hemorrhagic fluid was aspirated, which was negative for malignant cells. Fiberoptic bronchoscopy showed infiltration with mucosal edema in the medial wall of left main bronchus near the lingular opening. Nearby tertiary carina was also infiltrated and edematous. Histopathology of endobroncial and brush biopsy from infiltrated area showed adenocarcinoma (Figs 17.105 to 17.108).

CASE 38: SQUAMOUS CELL CARCINOMA IN A 55-YEAR-OLD MALE

This patient, smoker (40 bidi/day for 25 years) presented with cough, chest pain, hoarseness of voice, dysphagia and recurrent hemoptysis for 8 months. Fiberoptic bronchoscopy showed multinodular growth on anterolateral wall of trachea just above the main carina, making opening of trachea slit-like. Bronchoscope could not be negotiated further. Histopathology of endobronchial biopsy of the growth showed squamous cell carcinoma (Figs 17.109 to 17.112).

CASE 39: SMALL CELL CARCINOMA IN A 53-YEAR-OLD MALE

This patient, cigarette smoker (20 cigarette/day for 30 years) presented with weakness in both limbs, hemoptysis, hoarseness of voice, dysphagia, loss of weight and loss of appetite for 3 months. Fiberoptic bronchoscopy showed tumor obstructing left upper lobe bronchus (Figs 17.113 to 17.116). Histopathology of endobronchial biopsy showed small cell carcinoma. CT head showed secondaries in the brain.

CASE 40: ADENOCARCINOMA IN A 45-YEAR-OLD FEMALE

This patient, nonsmoker presented with cough, breathlessness, chest pain and loss of appetite for 6 months. She had recurrent pleural effusion and hemorrhagic pleural fluid was aspirated and pleural fluid cytology was positive for malignant cells. Fiberoptic bronchoscopy showed thick and edematous secondary carina near right upper lobe bronchus. All the lumens of right upper lobe, middle lobe and lower lobe were narrowed from outside compression. Histopathology of brush biopsy from right upper lobe bronchus showed adenocarcinoma (Figs 17.117 to 17.120).

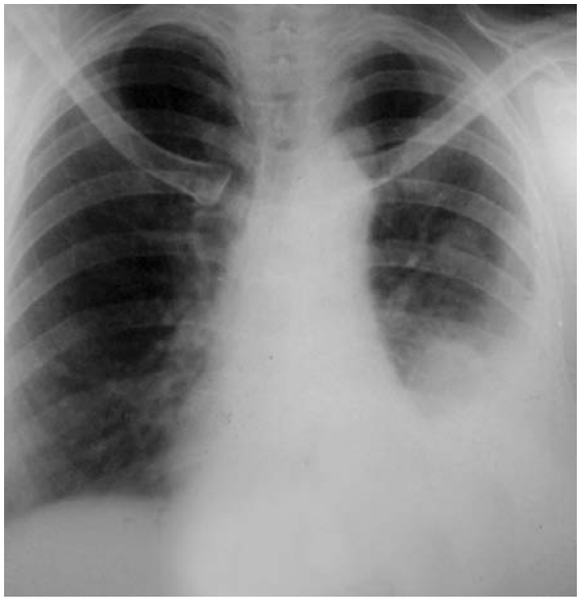

Fig. 17.105: Chest X-ray showing pleural effusion on left side

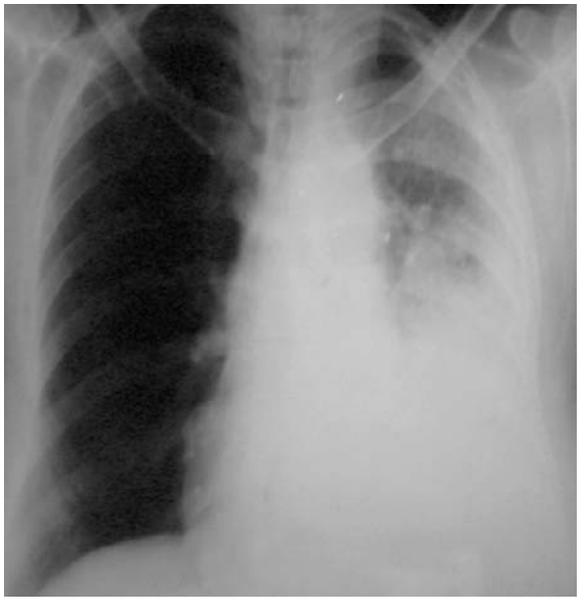

Fig. 17.106: Chest X-ray showing increased pleural effusion inspite of 6 months antituberculosis treatment (ATT)

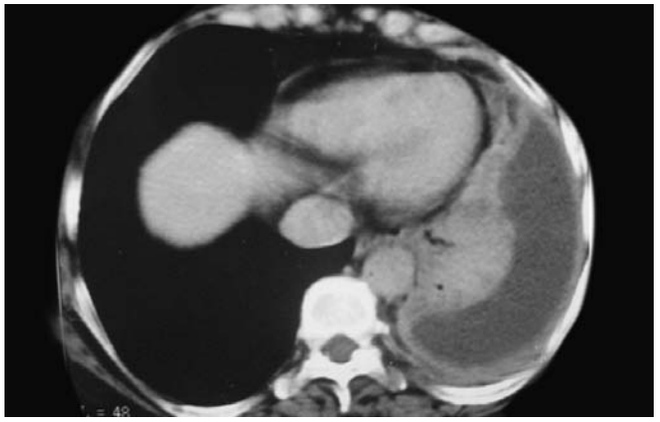

Fig. 17.107: CT thorax showing pleural effusion with mass on left side

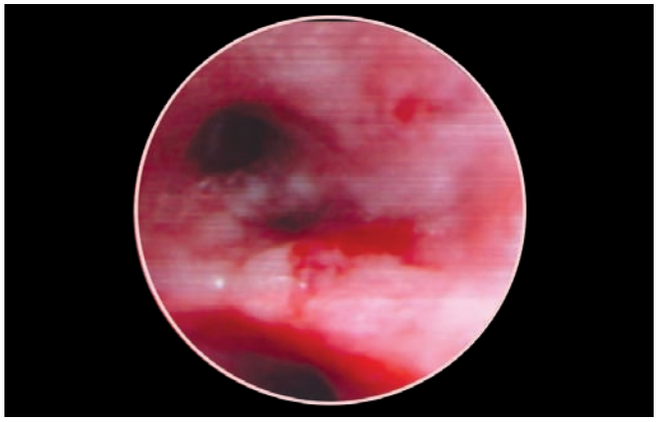

Fig. 17.108: Infiltrated bronchial wall and tertiary carina

Fig. 17.109: Chest X-ray showing mass in the right lung

Fig. 17.110: Chest X-ray lateral view showing mass in the right lung

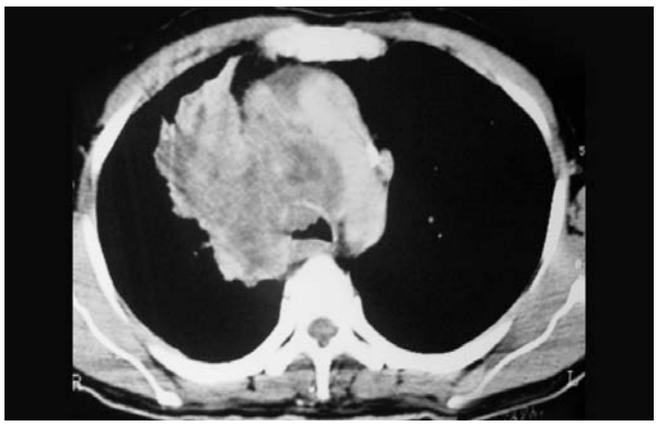

Fig. 17.111: CT thorax showing mass infiltrating trachea

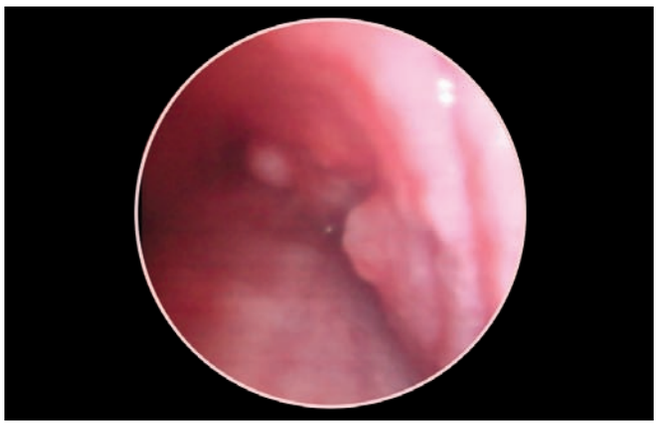

Fig. 17.112: Multinodular growth

Fig. 17.113: Chest X-ray showing mass in left lung

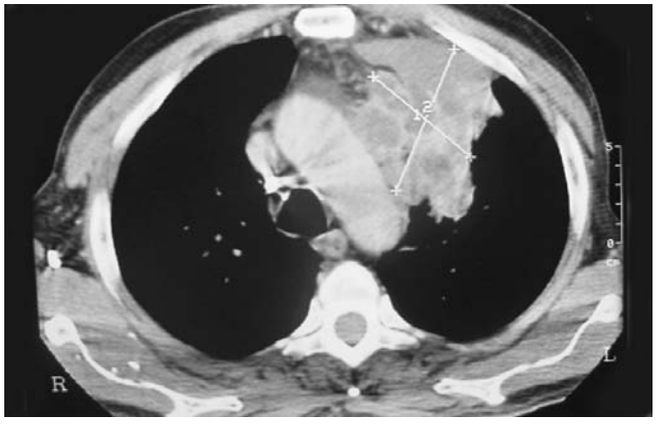

Fig. 17.114: CT thorax showing mass in left lung

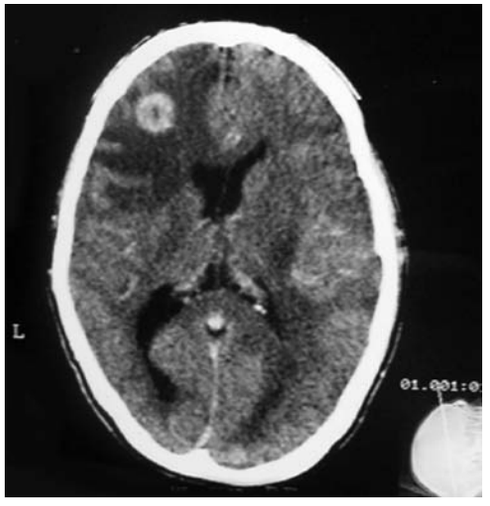

Fig. 17.115: CT head showing secondaries in brain

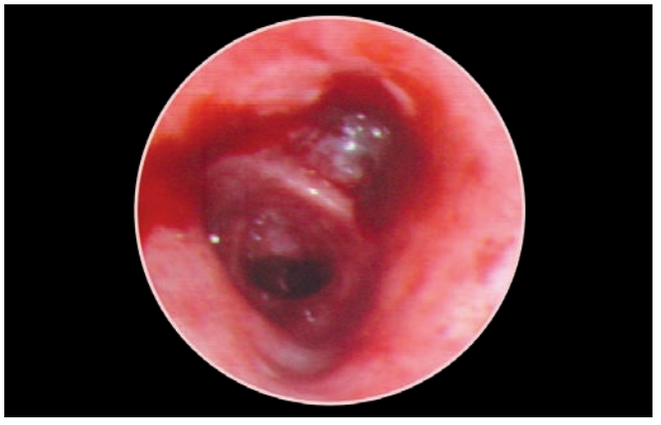

Fig. 17.116: Tumor obstructing left upper lobe bronchus

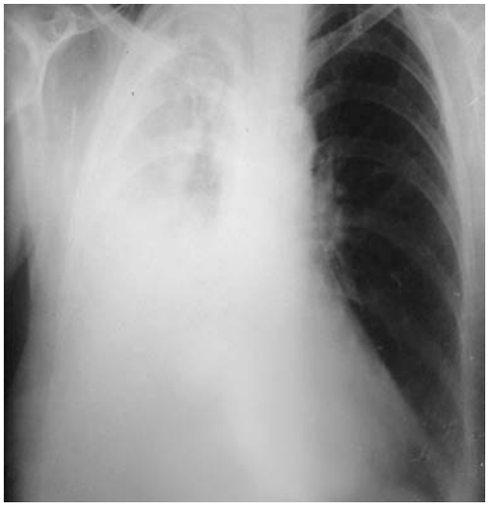

Fig. 17.117: Chest X-ray showing pleural effusion with central mediastinum

Fig. 17.118: Chest X-ray showing increased pleural effusion

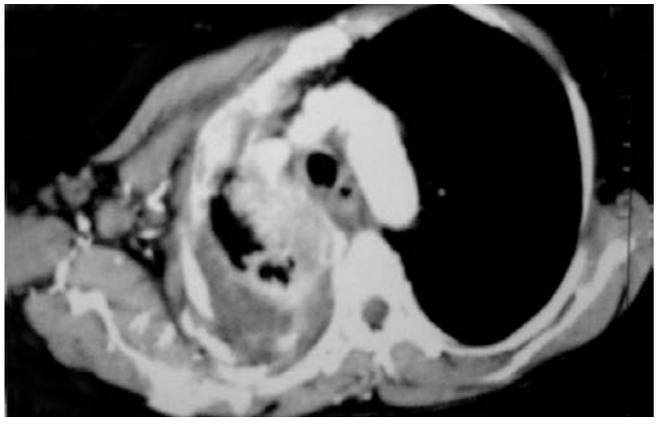

Fig. 17.119: CT thorax showing mass and pleural effusion

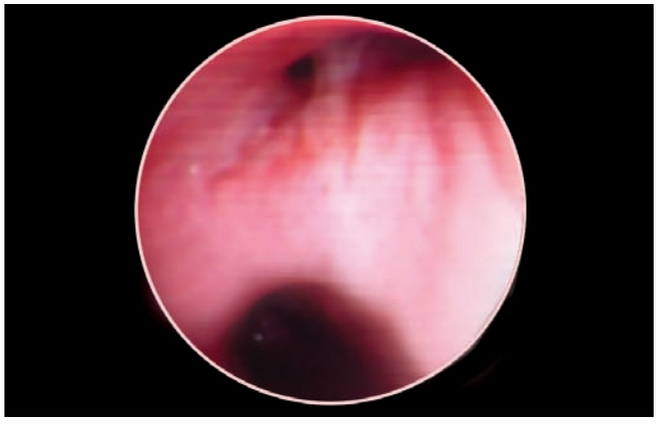

Fig. 17.120: Thick secondary carina near right upper lobe bronchus

CASE 41: LARGE CELL CARCINOMA IN A 45-YEAR-OLD MALE

This patient, bidi smoker (10 bidi/day for 25 years), presented with cough breathlessness, chest pain and loss of appetite for 6 months. He had pleural effusion, which was aspirated and was exudative in character and pleural fluid cytology was negative for malignant cells. He was misdiagnosed as tubercular effusion and antitubercular treatment was given for 5 months without any response. Fiberoptic bronchoscopy showed thickened secondary carina between left upper lobe bronchus and lower lobe bronchus. Tertiary carina was thick and infiltrated. Histopathology of endobronchial and brush biopsy showed large cell carcinoma (Figs 17.121 to 17.128).

CASE 42: SQUAMOUS CELL CARCINOMA IN A 61-YEAR-OLD FEMALE

This patient, bidi smoker (15 bidi/day for 35 years), a known case of COPD, presented with recurrent hemoptysis for 1 year. Fiberoptic bronchoscopy showed bulging of posterior wall of lower end of trachea from outside compression due to mass. Rest of the endobronchial tree had no lesion except changes of chronic bronchitis. Transtracheal needle aspiration was done and cytology of which showed squamous cell carcinoma (Figs 17.129 to 17.17.134).

CASE 43: ADENOSQUAMOUS CELL CARCINOMA IN A 40-YEAR-OLD MALE

This patient, nonsmoker presented with cough, chest pain for 8 months and hemoptysis for 1 month. He had an enlarged hard lymph node in left supraclavicular area. Fine needle aspiration cytology of the supraclavicular lymph node showed metastatic squamous cell carcinoma. Pleural fluid cytology was positive for malignant cells. Fiberoptic bronchoscopy showed anterior part of main carina wide. Lower lobe bronchus is narrowed and full of blood. After saline wash there was multiple nodular growth on the wall of left lower lobe bronchus. Histopathology of endobronchial biopsy showed histology of adenosquamous carcinoma (Figs 17.135 to 138).

CASE 44: SQUAMOUS CELL CARCINOMA IN A 71-YEAR-OLD FEMALE

This patient, nonsmoker presented with cough, chest pain for 1 year, breathlessness for 6 months and hemoptysis for 2 months. Fiberoptic bronchoscopy showed tumor covered with necrotic slough obstructing left main bronchus. Histopathology of endobronchial and brush biopsy was consistent with squamous cell carcinoma (Figs 17.139 to 17.142).

Fig. 17.121: Chest X-ray showing pleural effusion on left side

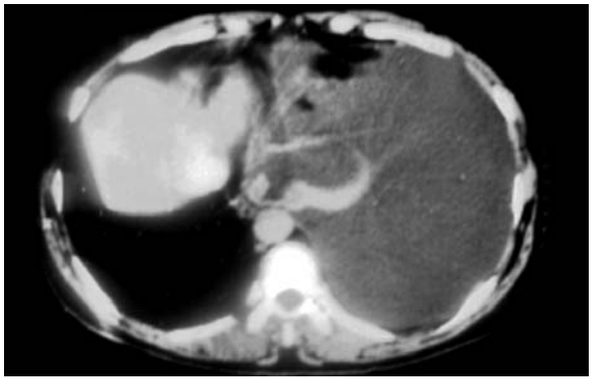

Fig. 17.122: CT thorax showing pleural effusion on left side

Fig. 17.123: Chest X-ray showing mass with pleural effusion on left side

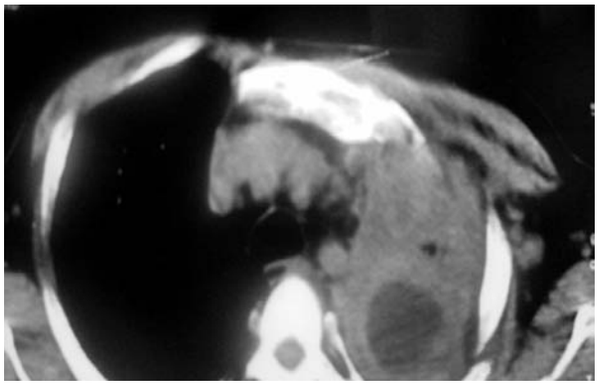

Fig. 17.124: CT thorax showing mass with necrosis

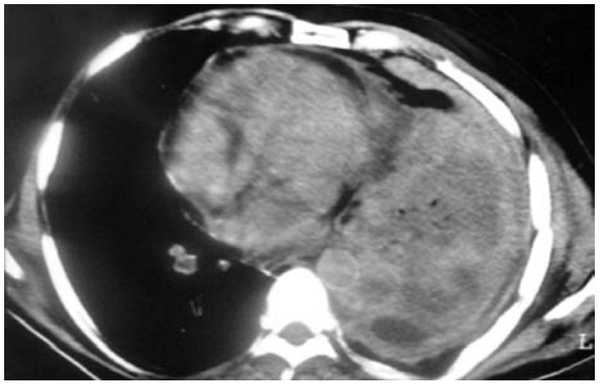

Fig. 17.125: CT thorax showing necrotic mass with small pleural effusion

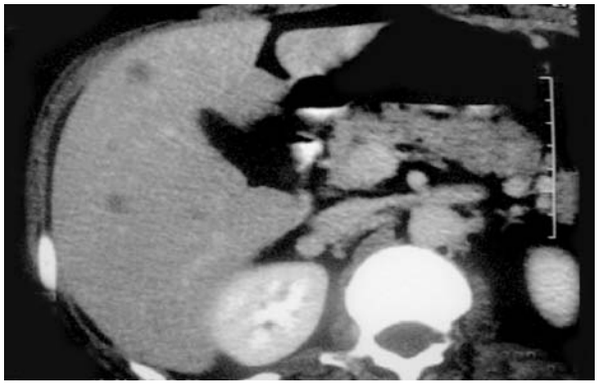

Fig. 17.126: CT thorax showing secondaries in liver

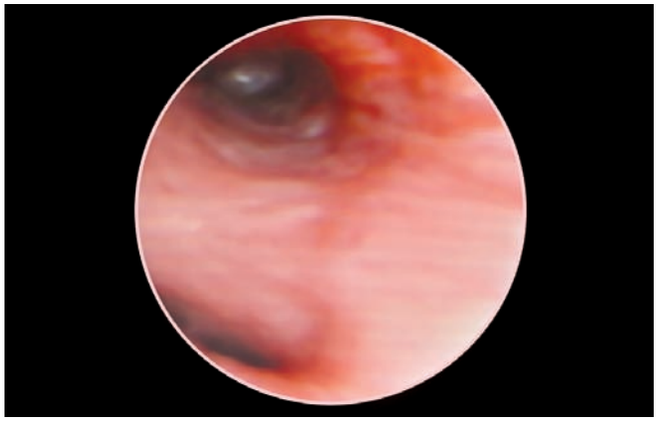

Fig. 17.127: Thick secondary carina

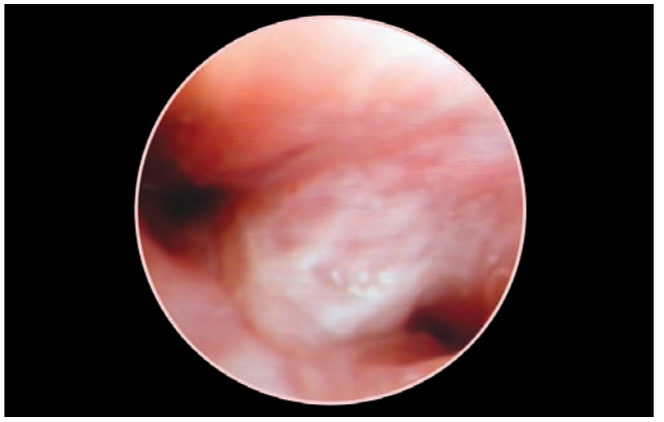

Fig. 17.128: Tertiary carina thick, edematous and infiltrated

Fig. 17.129: Mass in right paratrachial area

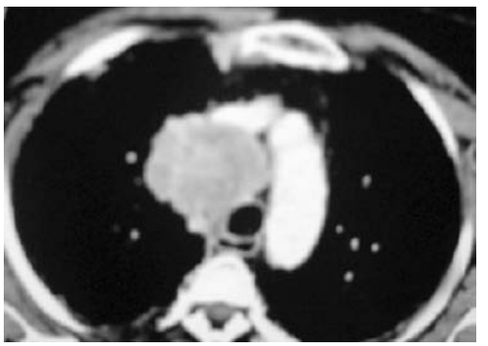

Fig. 17.130: Mass in right paratrachial area

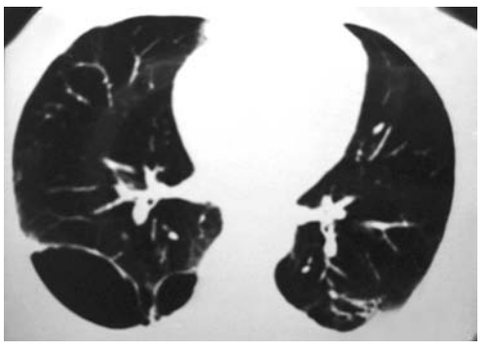

Fig. 17.131: Multiple bullae

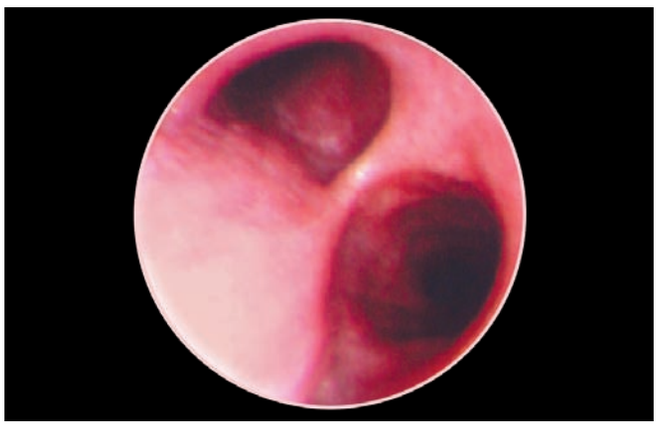

Fig. 17.132: Bulging of lower end of trachea

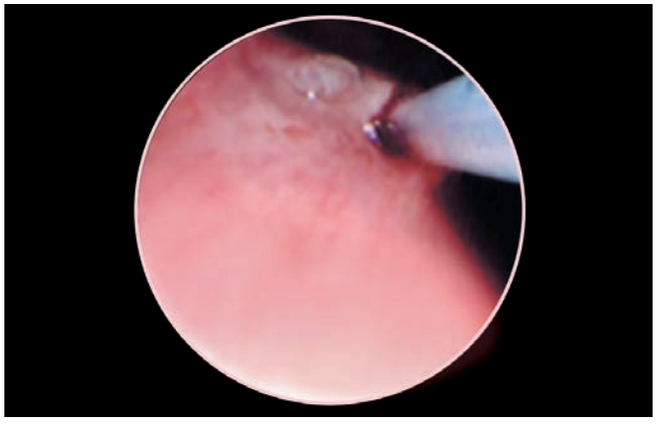

Fig. 17.133: Transtracheal needle aspiration

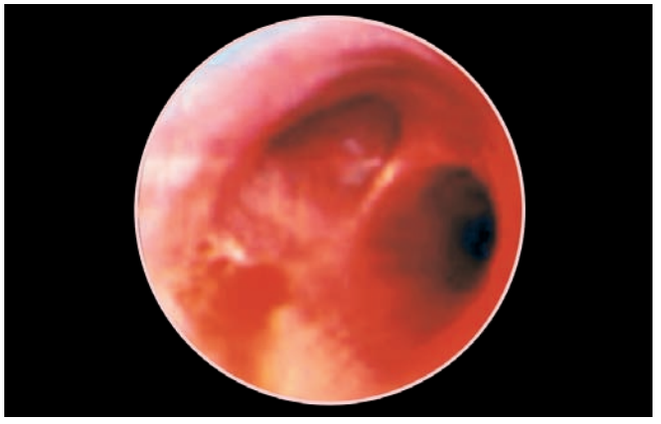

Fig. 17.134: Bleeding after transtracheal needle aspiration

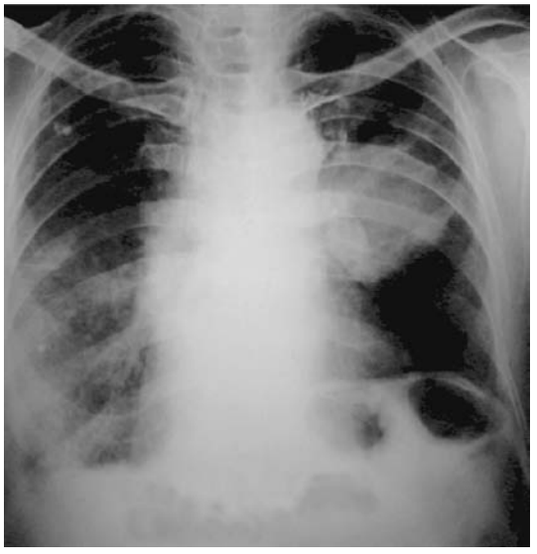

Fig. 17.135: Chest X-ray showing radio-opaque shadow in left lower zone

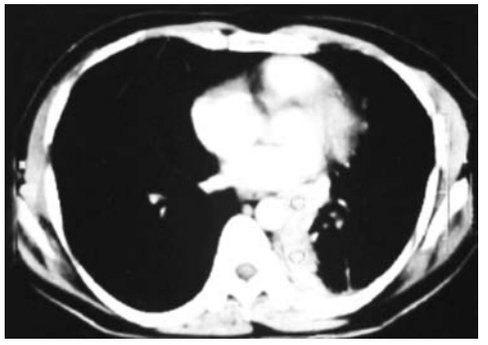

Fig. 17.136: CT thorax showing mass in left lung

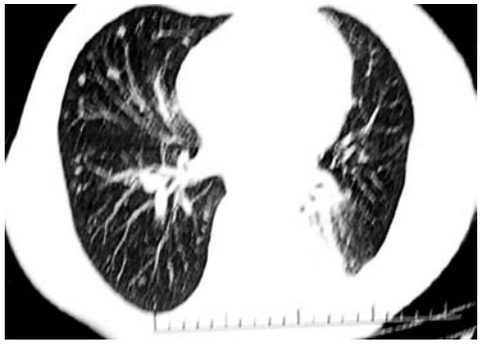

Fig. 17.137: CT thorax showing secondaries in lung

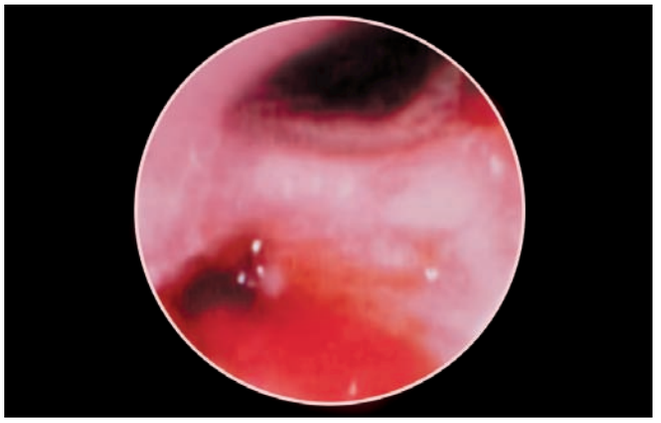

Fig. 17.138: Tumor with blood in left lower lobe bronchus

Fig. 17.139: Chest X-ray showing collapse of left lung

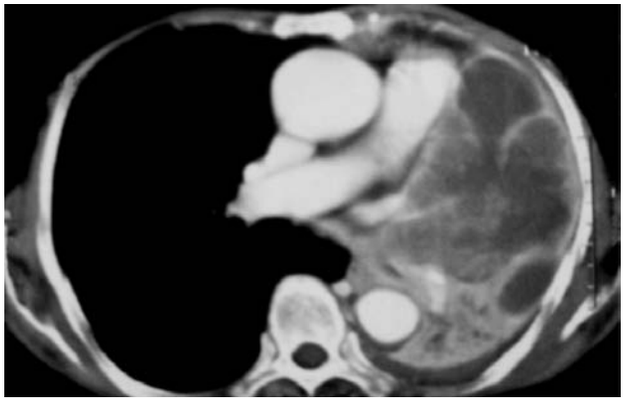

Fig. 17.140: CT thorax showing mass with necrosis

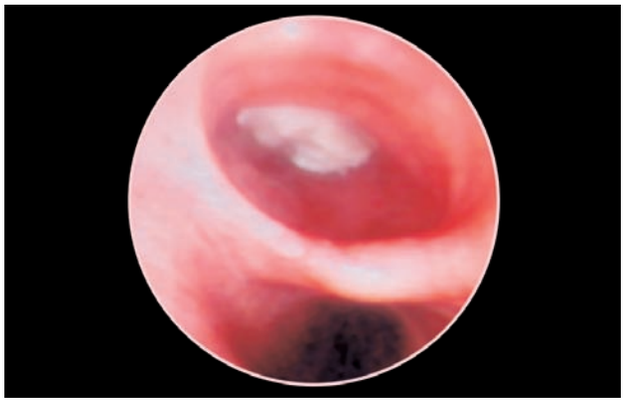

Fig. 17.141: Tumor with necrotic slough

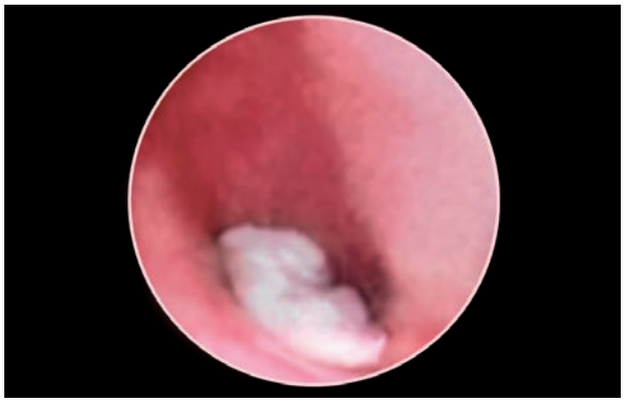

Fig. 17.142: Tumor with necrotic slough—close view

CASE 45: SQUAMOUS CELL CARCINOMA IN A 50-YEAR-OLD MALE

This patient, cigarette smoker (25 cigarette/day for 30 years), a known case of COPD for last 10 years, presented with recurrent hemoptysis for last 6 months. Chest X-ray had no obvious lesions except changes of COPD. Fiberoptic bronchoscopy showed tumor in the right main bronchus involving carina. Endobronchial biopsy showed histopathology of squamous cell carcinoma (Figs 17.143 to 17.146).

CASE 46: LARGE CELL CARCINOMA IN A 56-YEAR-OLD MALE

This patient, occasional smoker, presented with recurrent pleural effusion for last 3 months. Hemorrhagic pleural fluid was aspirated thrice and pleural fluid cytology was positive for malignant cells. Fiberoptic bronchoscopy showed thick secondary carina near right upper lobe bronchus and tertiary carina between apical and posterior segment of right upper lobe is wide and infiltrated reducing the lumen of apical segment. There is an evidence of compression of right middle and lower lobe bronchus. Histopathology of endobronchial biopsy showed large cell carcinoma (Figs 17.147 to 17.150).

CASE 47: SQUAMOUS CELL CARCINOMA IN A 38-YEAR-OLD MALE

This patient, bidi smoker (12 bidi/day for 22 years) presented with cough, chest pain, dyspnea and loss of appetite for 3 months and dysphagia for 2 months. Fiberoptic

bronchoscopy showed tumor covered with necrotic slough obstructing right main bronchus. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.151 to 17.154).

CASE 48: SQUAMOUS CELL CARCINOMA IN A 53-YEAR-OLD FEMALE

This patient, nonsmoker presented with cough, chest pain, dyspnea and loss of appetite for 4 months. Fiberoptic bronchoscopy showed short and thick main carina deviated to left side. Left main bronchus was full of blood clots, but after normal saline wash, a cauliflower-like growth was visualized. Bronchoscope could not be passed further. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.155 to 17.158).

CASE 49: SQUAMOUS CELL CARCINOMA IN A 45-YEAR-OLD MALE

This patient, nonsmoker, had received three full courses of antitubercular treatment in 1978, 1986,1996, with good response every time. Now presented with cough, chest pain, breathlessness, streaking and hoarseness of voice for 3 months. Fiberoptic bronchoscopy showed no movement in the left vocal cord. There was fragile tumor in left main bronchus 2 cm away from carina, which was covered with necrotic slough. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.159 to 17.162).

CASE 50: SQUAMOUS CELL CARCINOMA IN A 60-YEAR-OLD MALE

This patient, bidi smoker (15/day for 20 years), presented with cough and expectoration, loss of appetite and weight for 3 months. Fiberoptic bronchoscopy showed posterior wall of the trachea was bulging and its lumen was narrowed from outside compression. Mucosa of anterior and lateral wall of left main bronchus was hypertrophied and hyperemic and infiltrated. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.163 to 17.166).

CASE 51: LARGE CELL CARCINOMA IN A 70-YEAR-OLD MALE

This patient, nonsmoker presented with loss of appetite for 3 months and hemoptysis for 15 days. CT thorax showed irregularly marginated heterogenously enhancing soft-tissue mass in right upper lobe. Fiberoptic bronchoscopy showed tumor covered with necrotic slough coming out from right upper lobe bronchus. Division of the left upper lobe is like right upper lobe bronchus (bronchial isomerism). Histopathology of endobranchial brush and forceps biopsy showed large cell carcinoma (Figs 17.167 to 17.170).

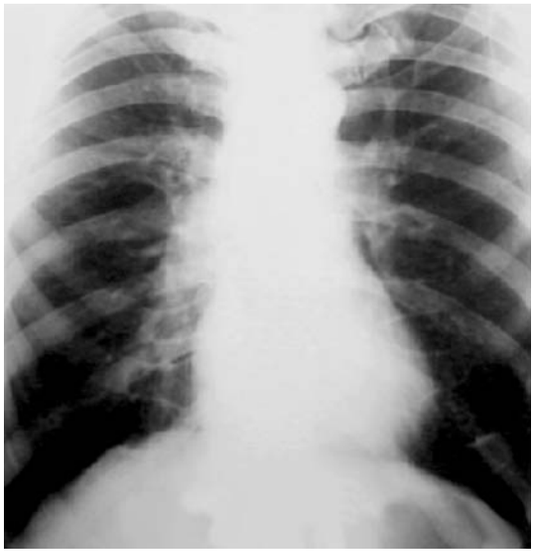

Fig. 17.143: Chest X-ray with in normal limits except findings suggestive of chronic obstructive pulmonary disease

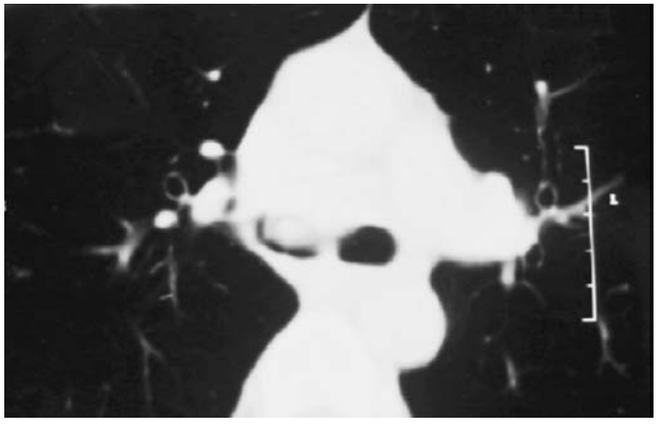

Fig. 17.144: CT thorax showing mass in right main bronchus

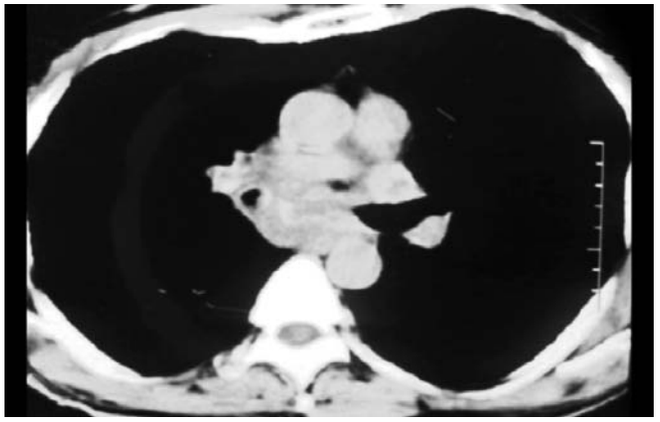

Fig. 17.145: CT thorax showing intrathoracic mass

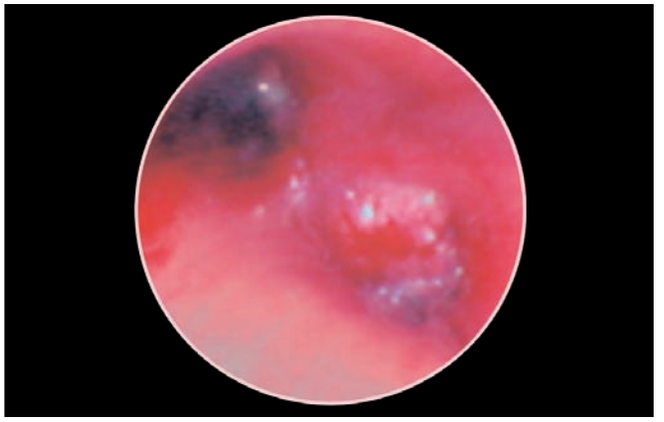

Fig. 17.146: Tumor in right main bronchus involving main carina

Fig. 17.147: Chest X-ray posteroanterior (PA) view showing pleural effusion on right side

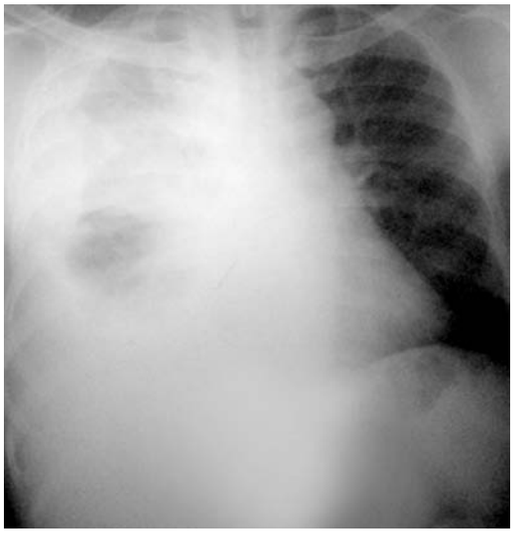

Fig. 17.148: Chest X-ray showing underlying mass after pleural fluid aspiration

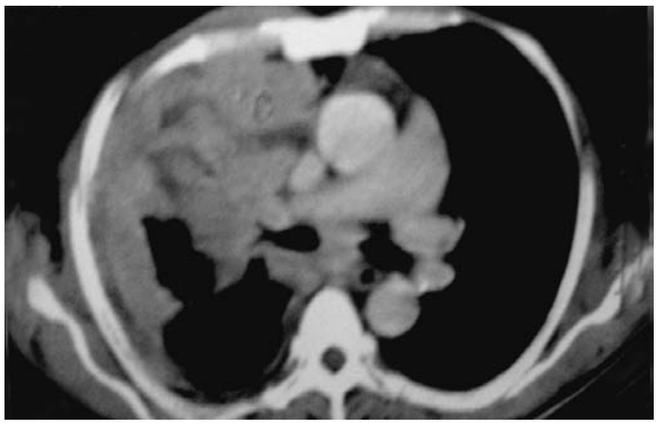

Fig. 17.149: CT thorax showing mass with pleural effusion

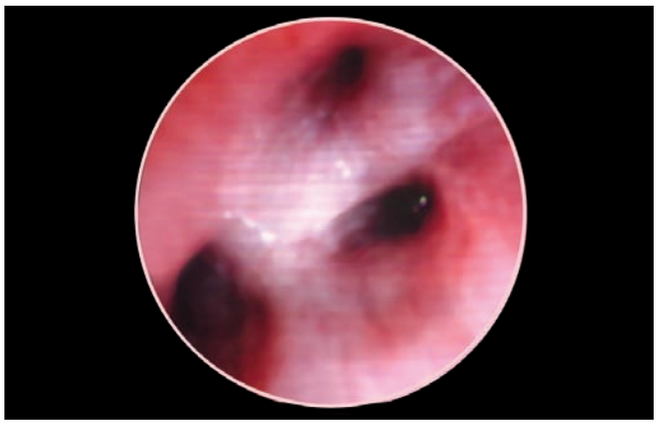

Fig. 17.150: Tertiary carina between apical and posterior segment of right upper lobe is wide and infiltrated reducing the lumen of apical segment

Fig. 17.151: Chest X-ray looking normal

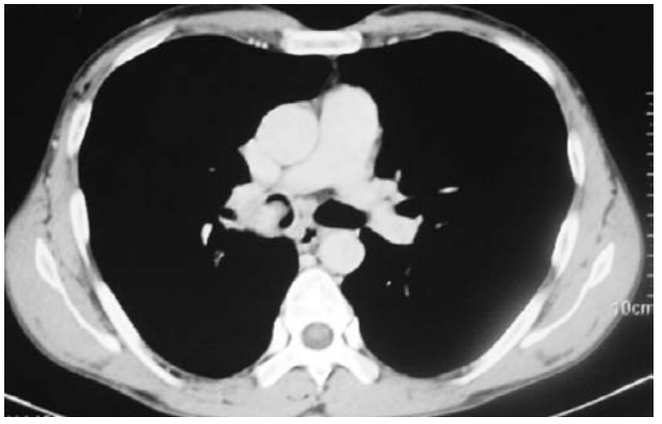

Fig. 17.152: CT thorax showing growth in right main bronchus

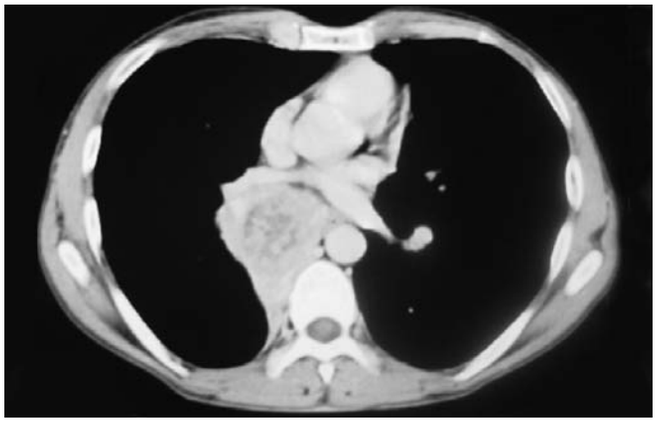

Fig. 17.153: CT thorax showing intrathoracic mass

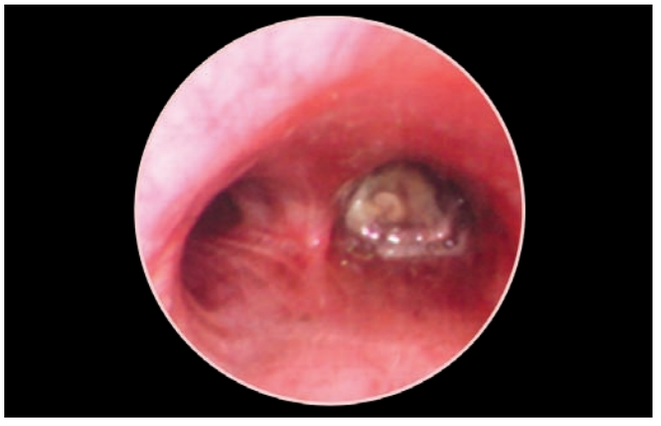

Fig. 17.154: Tumor covered with necrotic slough right main bronchus

Fig. 17.155: Chest X-ray showing collapse with effusion on left side

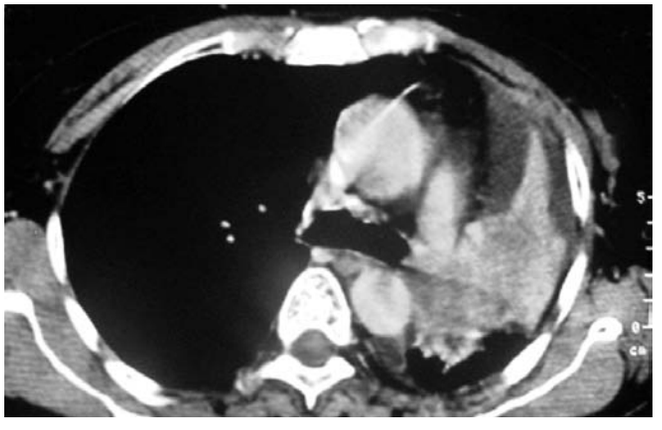

Fig. 17.156: CT thorax showing intrathoracic mass in left lung with effusion

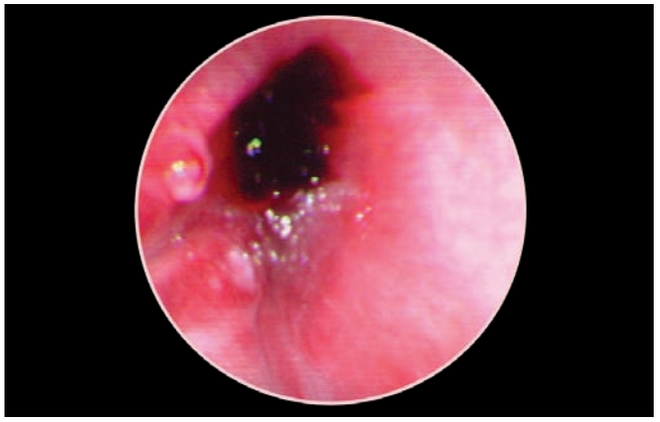

Fig. 17.157: Left main bronchus full of blood clots

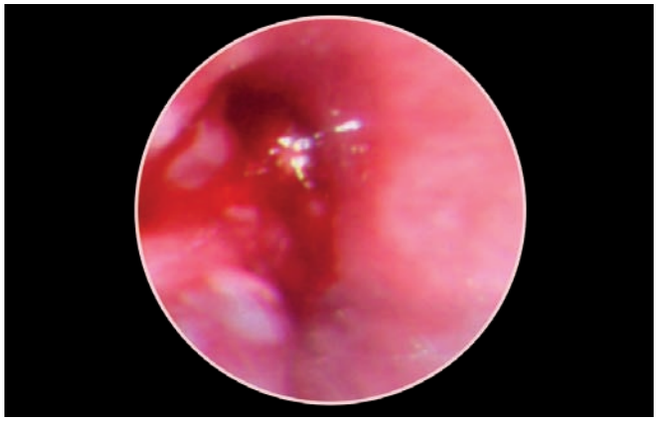

Fig. 17.158: Cauliflower-like growth in left main bronchus

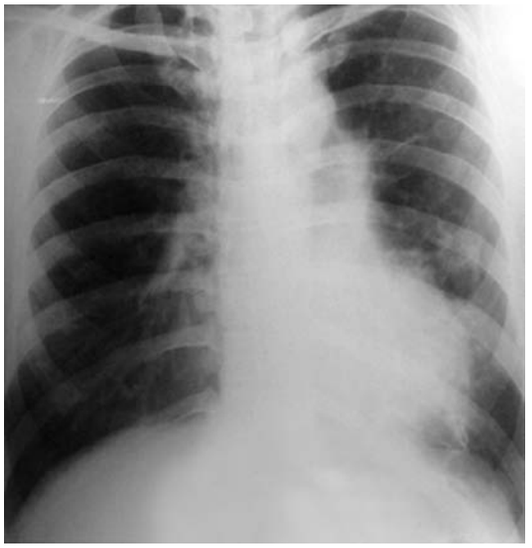

Fig. 17.159: Chest X-ray after last course of antitubercular treatment (ATT) in 1996

Fig. 17.160: Chest X-ray showing mass left lung

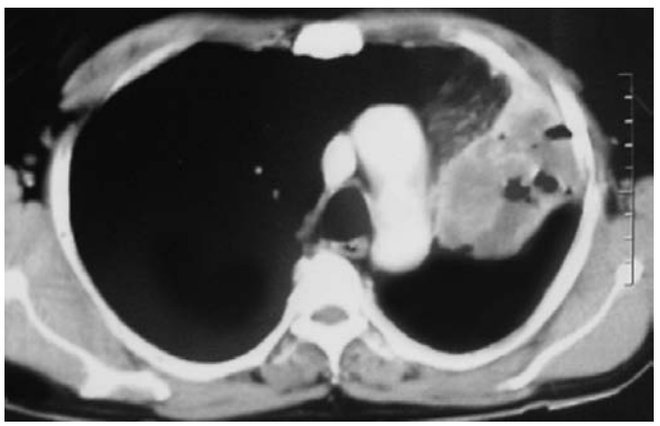

Fig. 17.161: CT thorax showing intrathoracic mass

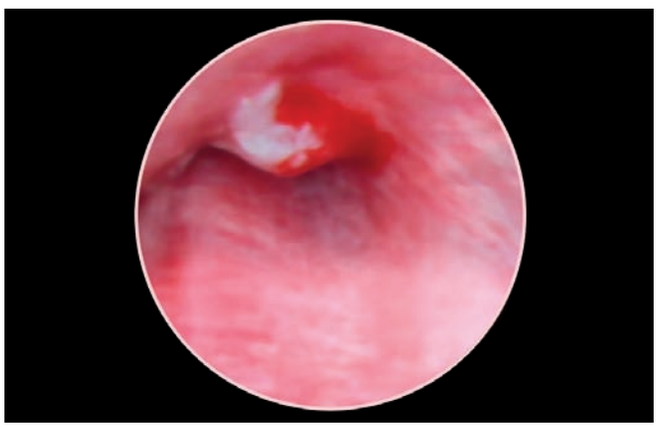

Fig. 17.162: Tumor in left main bronchus

Fig. 17.163: Chest X-ray showing mass in left parahilar area with pleural effusion on right side

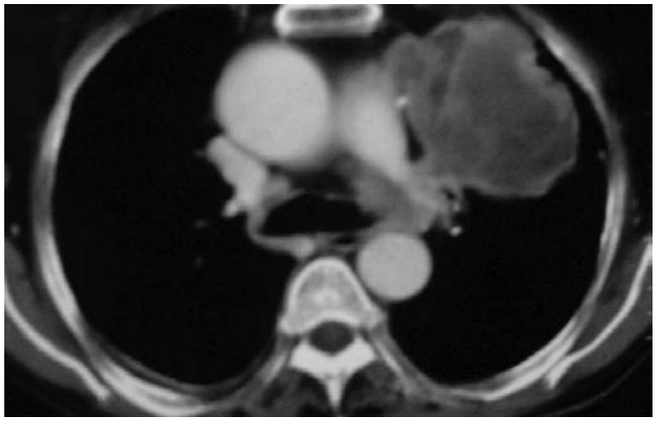

Fig. 17.164: CT thorax showing intrathoracic mass on left side

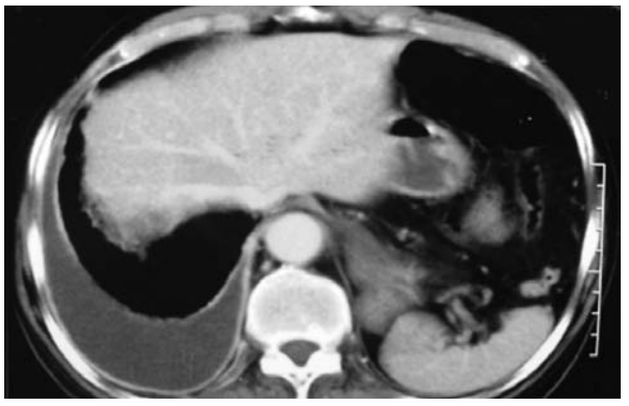

Fig. 17.165: CT thorax showing pleural effusion on the right side

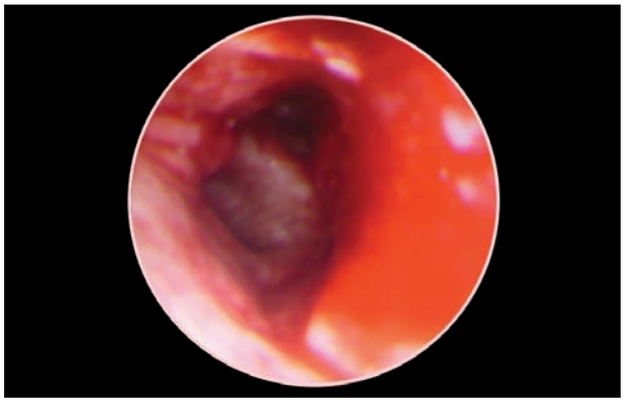

Fig. 17.166: Infiltration of left main bronchus

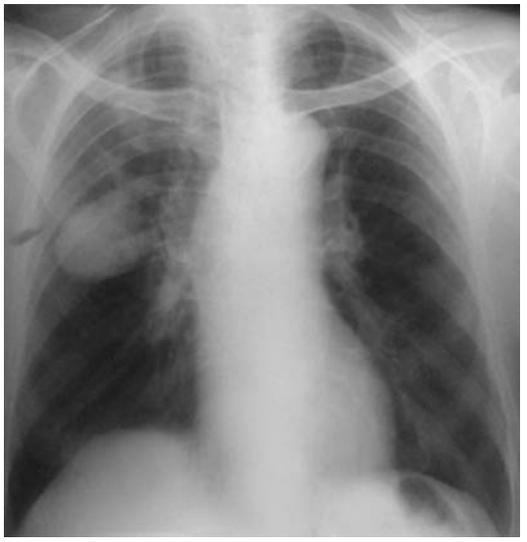

Fig. 17.167: Chest X-ray showing rounded opacity right mid zone

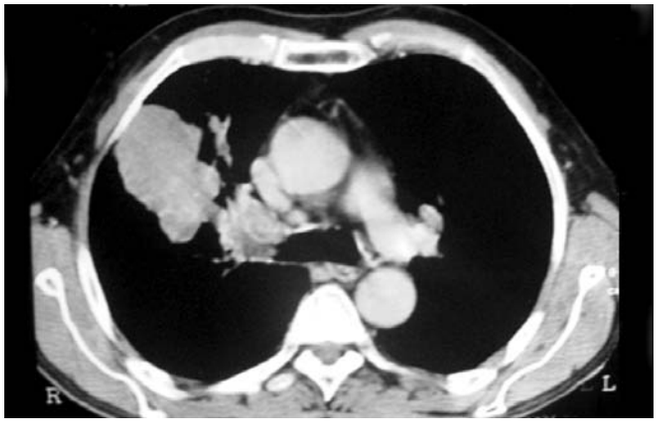

Fig. 17.168: CT thorax showing intrathoracic mass right lung

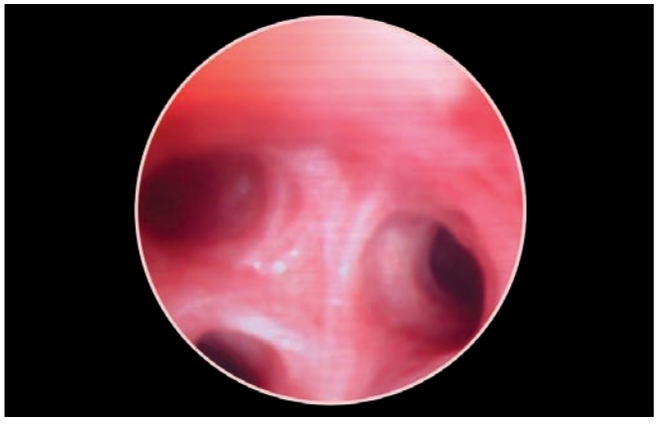

Fig. 17.169: Division of the left upper lobe is like right upper lobe bronchus (bronchial isomerism)

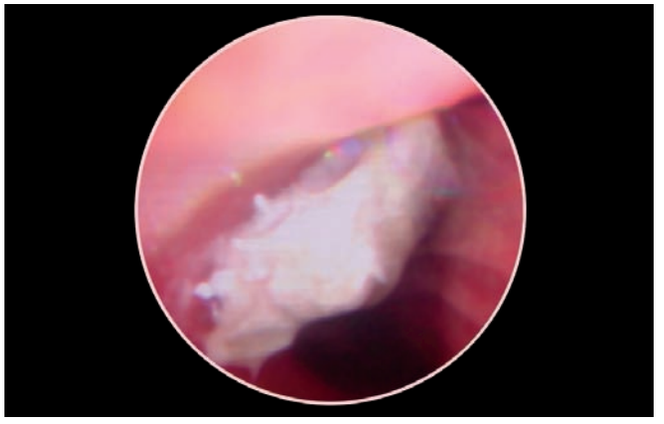

Fig. 17.170: Tumor covered with necrotic slough coming out from right upper lobe bronchus

CASE 52: SQUAMOUS CELL CARCINOMA IN A 55-YEAR-OLD MALE

This patient, bidi smoker (20/day for 40 years) presented with cough, breathlessness for 3 months and decreased appetite for 1 month. CT thorax showed large heterogenously enhancing mass in right middle zone, arising from right hilar extending up to right anterior chest wall. Fiberoptic bronchoscopy showed nodule over anterior part of left vocal card. Main carina was short and thick. Right main bronchus was narrowed and infiltrated by tumor. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.171 to 17.174).

CASE 53: BRONCHIOLOALVEOLAR CARCINOMA IN A 50-YEAR-OLD MALE

This patient, bidi smoker (14/day for 30 years), presented with dry cough, chest pain and loss of weight for 6 months and streaking for 15 days. Fiberoptic bronchoscopy showed a tumor covered with necrotic slough, obstructing posterior segmental bronchus of right upper lobe. Histopathology of endobronchial and brush biopsy showed bronchoalveolar carcinoma (Figs 17.175 to 17.178).

CASE 54: SQUAMOUS CELL CARCINOMA IN A 52-YEAR-OLD MALE

This patient, bidi smoker (20/day for 35 years) a known case of COPD for last 10 years, has developed loss of appetite and weight for last 6 months. CT thorax showed large heterogeneously enhancing mass in right paracardiac area with emphysematous changes in both lungs. Fiberoptic bronchoscopy showed irregular growth obstructing right middle lobe bronchus. Histopathology of endobronchial biopsy showed squamous cell carcinoma (Figs 17.179 to 17.182).

CASE 55: SMALL CELL CARCINOMA IN A 70-YEAR MALE

This patient, bidi smoker (20/day for 30 years), presented with cough, fever, breathlessness, hemoptysis for last 1 month and change of voice for 10 days. Chest X-ray showed lobulated soft-tissue lesion in right lower zone with mediastinal widening. Multiple nodular lesion are also seen near the mass. CT thorax showed enlarged pretracheal, paratracheal, subcarinal and aortapulmonary window lymph nodes. Multiple hypodense lesions seen in liver. Fiberoptic bronchoscopy showed irregular growth in anterior and lateral walls of the lower end of trachea reducing the lumen of trachea. Bronchoscope could not be negotiated further. Histopathology of endobronchial and brush biopsy showed small cell carcinoma (Figs 17.183 to 17.190).

CASE 56: SMALL CELL CARCINOMA IN A 51-YEAR-OLD MALE

This patient, bidi smoker (20/day for 25 years), a known case of COPD for last 4 years, had developed recurrent

hemoptysis for last 1 year. CT thorax showed large mass in left lower lobe infiltrating mediastinum with multiple mediastinal lymphadenopathy with pleural effusion. Fiberoptic bronchoscopy showed bulging of posterior wall of trachea in lower part. Main carina was short and wide. Right endobronchial tree showed evidences of chronic bronchitis, the lumen of left main bronchus was narrowed and medial wall of left main bronchus was infiltrated in whole of its length. Histopathology of endobronchial biopsy showed squamous cell carcinoma (Figs 17.191 to 17.198).

CASE 57: SMALL CELL CARCINOMA IN A 56-YEAR-OLD MALE

This patient, bidi smoker (15/day for 43 years), a known case of COPD presented with fever, loss of appetite and hoarseness of voice for 2 months. Fiberoptic bronchoscopy showed evidence of chronic bronchitis in both endobronchial tree with infiltration of posterior wall of left upper lobe bronchus reducing its lumen. Histopathology of endobronchial and brush biopsy showed of small cell carcinoma (Figs 17.199 to 17.202).

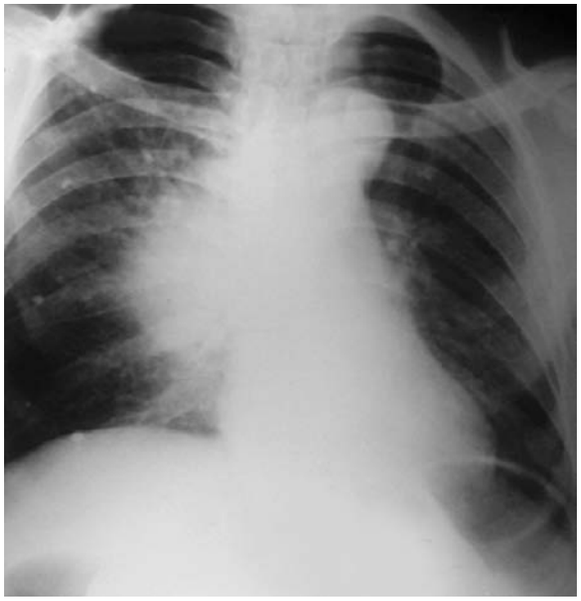

Fig. 17.171: Chest X-ray posteroanterior (PA) view showing mass in right parahilar area

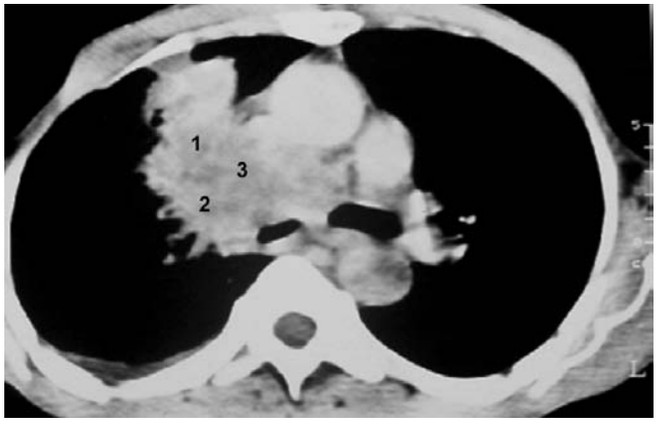

Fig. 17.172: CT thorax showing intrathoracic mass

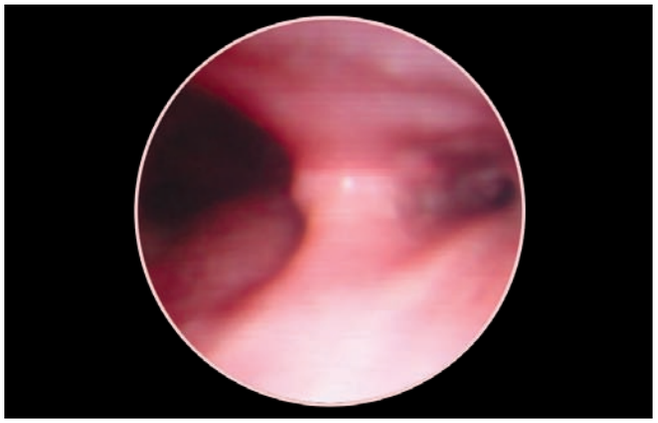

Fig. 17.173: Short and wide main carina

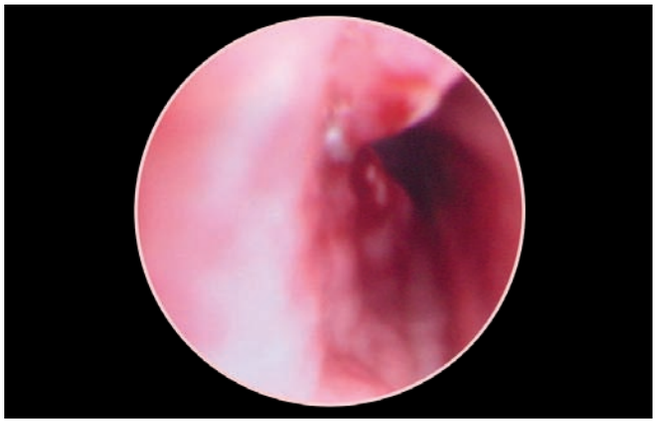

Fig. 17.174: Infiltration right main bronchus

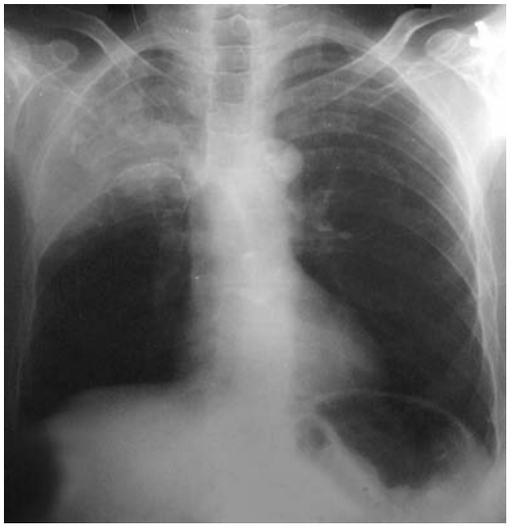

Fig. 17.175: Chest X-ray showing mass with destruction of adjacent ribs

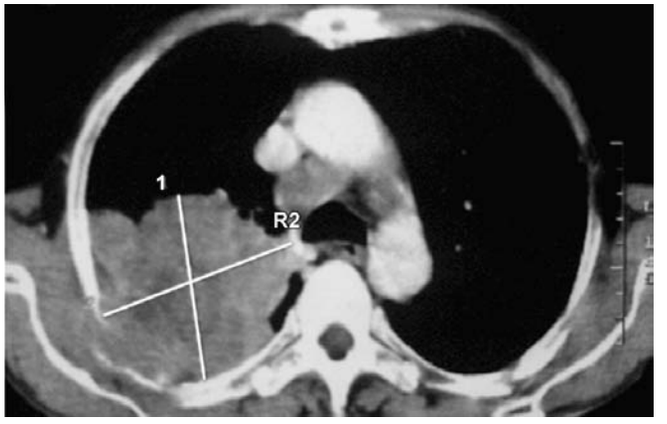

Fig. 17.176: CT thorax showing intrathoracic mass with chest wall involvement with right paratracheal lymph node

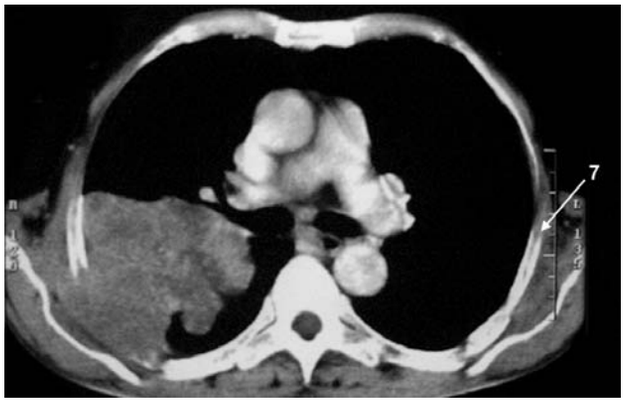

Fig. 17.177: CT thorax showing intrathoracic mass with mediastinal lymph node

Fig. 17.178: Tumor covered with necrotic slough obstructing posterior segment of right upper lobe bronchus

Fig. 17.179: Chest X-ray showing rounded opacity in right paracardiac area

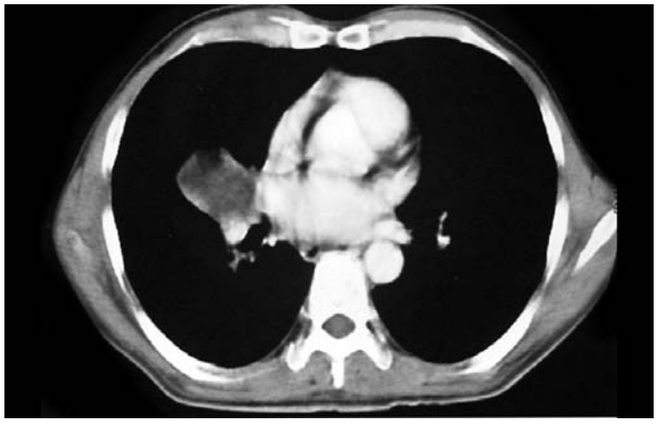

Fig. 17.180: CT thorax showing intrathoracic mass

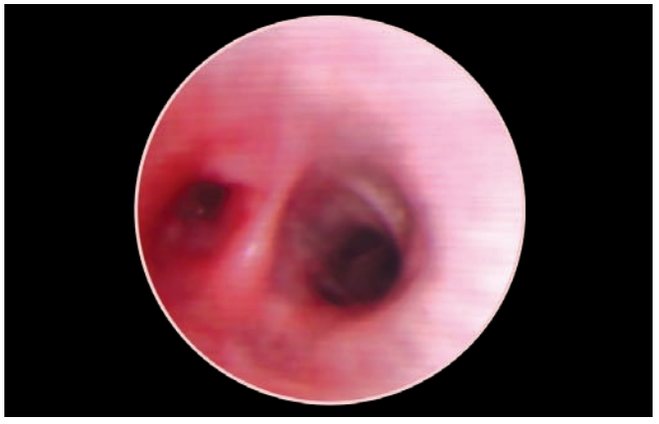

Fig. 17.181: Middle lobe bronchus—narrowed and hyperemic

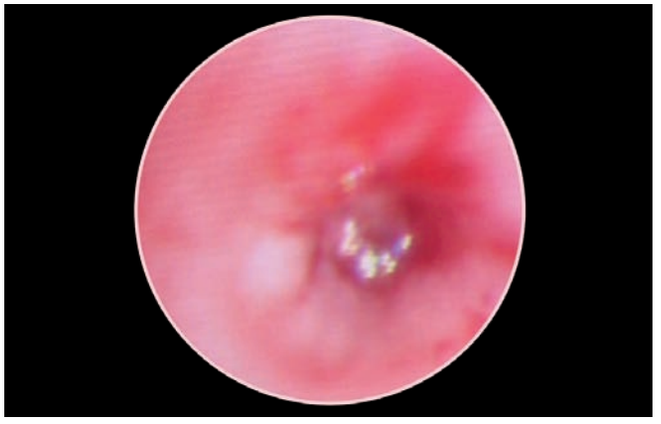

Fig. 17.182: Tumor obstructing right middle lobe bronchus

Fig. 17.183: Chest X-ray showing mediastinal widening with radio-opaque shadow in right lower zone

Fig. 17.184: CT thorax showing intrathoracic mass with mediastinal lymph nodes

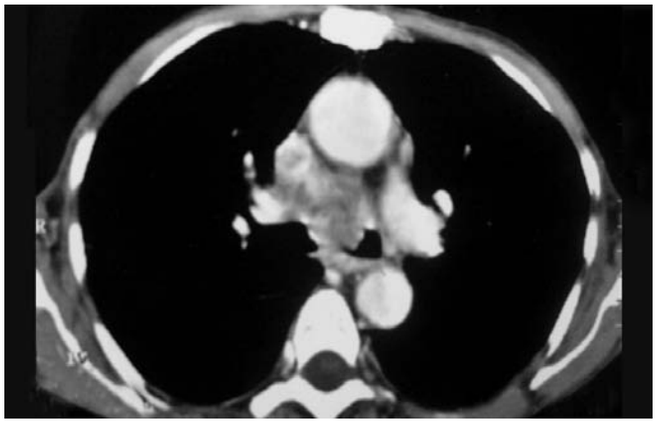

Fig. 17.185: CT thorax showing intrathoracic mass with mediastinal lymph nodes

Fig. 17.186: CT thorax showing intrathoracic mass with mediastinal lymph nodes

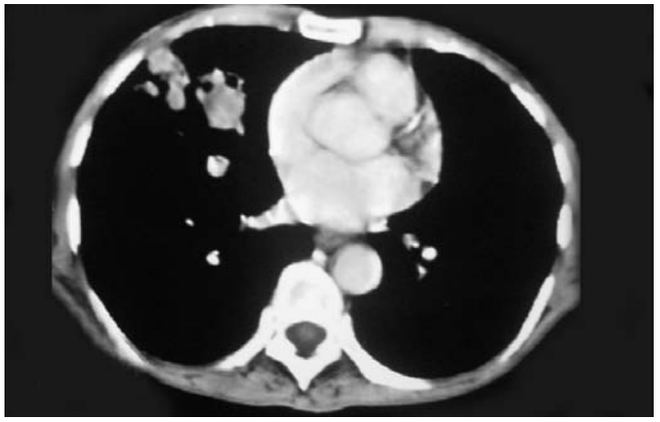

Fig. 17.187: CT thorax showing multiple nodules

Fig. 17.188: CT thorax showing multiple hypodense lesions in liver

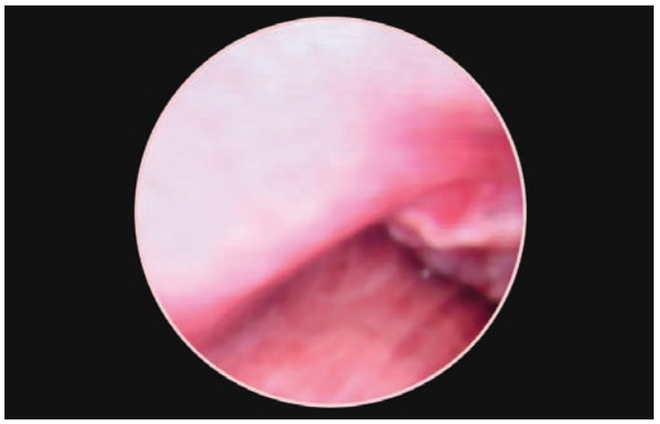

Fig. 17.189: Irregular growth in anterior and lateral walls of lower end of trachea, just before main carina

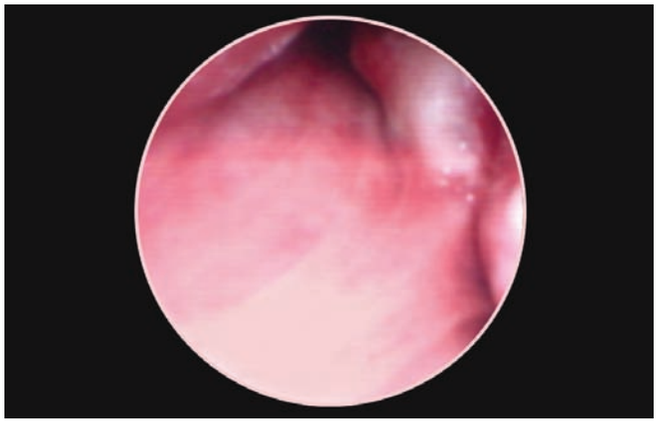

Fig. 17.190: Growth at lower end of trachea

Fig. 17.191: Chest X-ray showing mass in left parahilar area

Fig. 17.192: Chest X-ray showing mass in left parahilar area, which has increased in size

Fig. 17.193: Chest X-ray lateral view showing rounded opacity

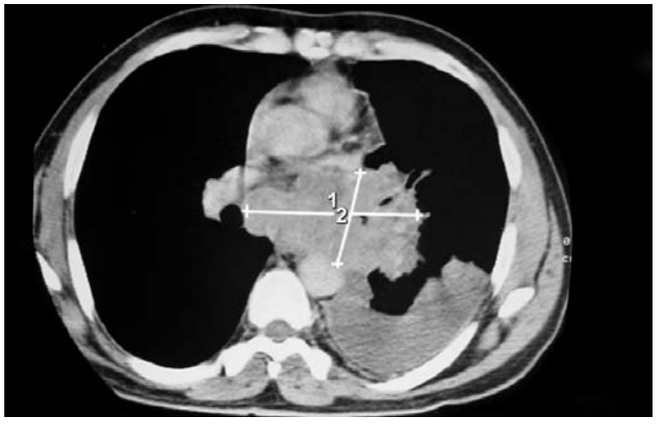

Fig. 17.194: CT thorax showing intrathoracic mass with mediastinal lymphadenopathy with pleural effusion

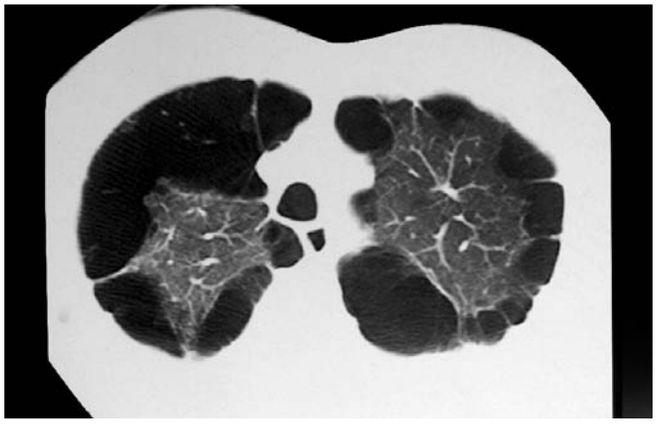

Fig. 17.195: CT thorax showing multiple bullae

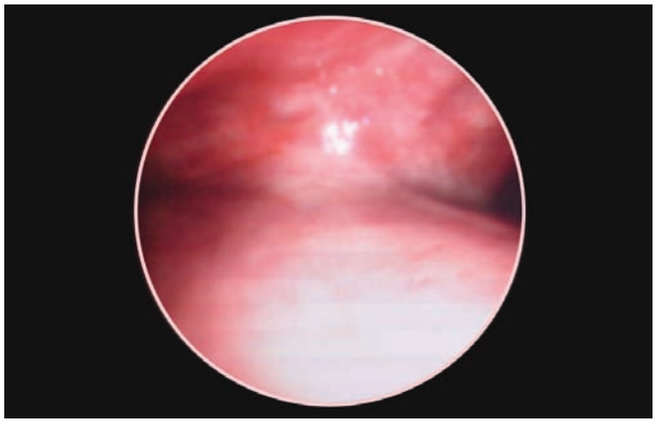

Fig. 17.196: Main carina is short, wide and infiltrated

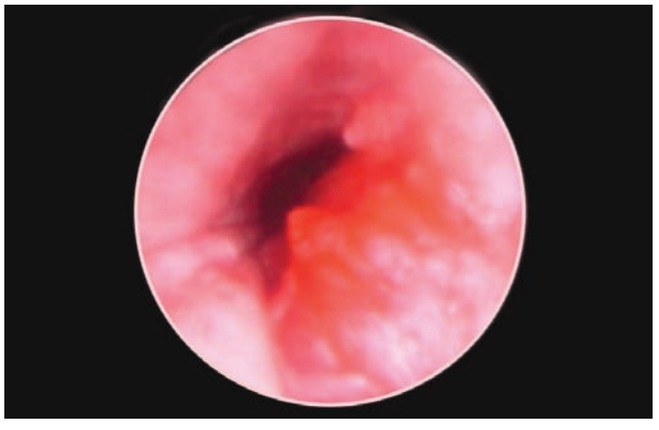

Fig. 17.197: Multiple nodules over medial wall of left main bronchus

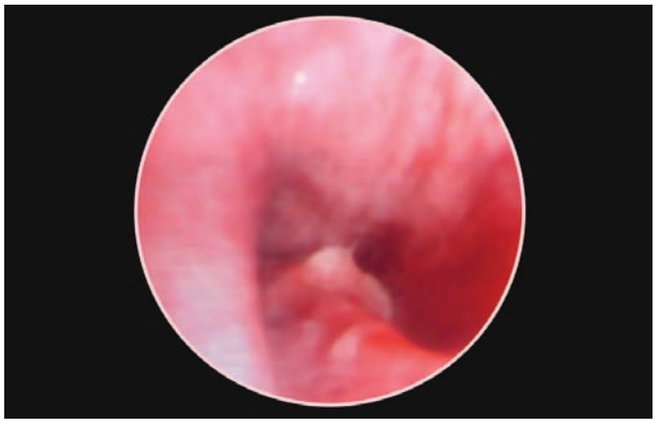

Fig. 17.198: Infiltration of the left main bronchus

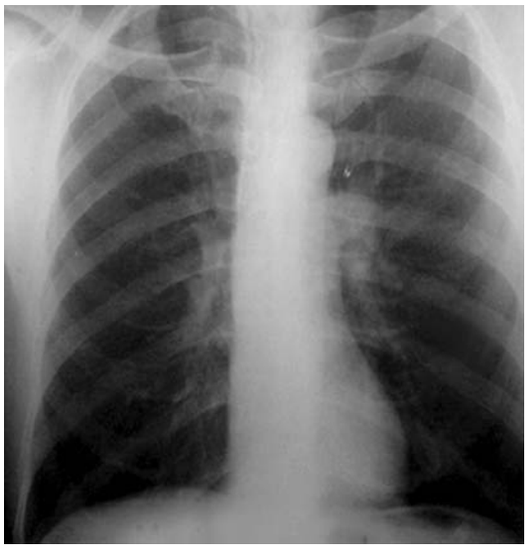

Fig. 17.199: Chest X-ray showing emphysematous changes with left hilar prominence

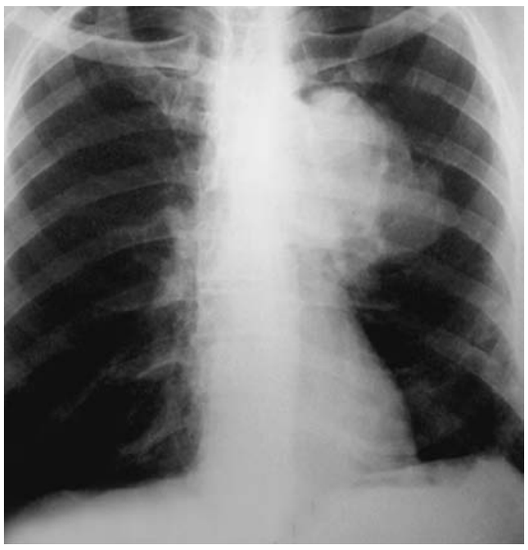

Fig. 17.200: Chest X-ray showing emphysematous changes with left hilar prominence, which has increased in size

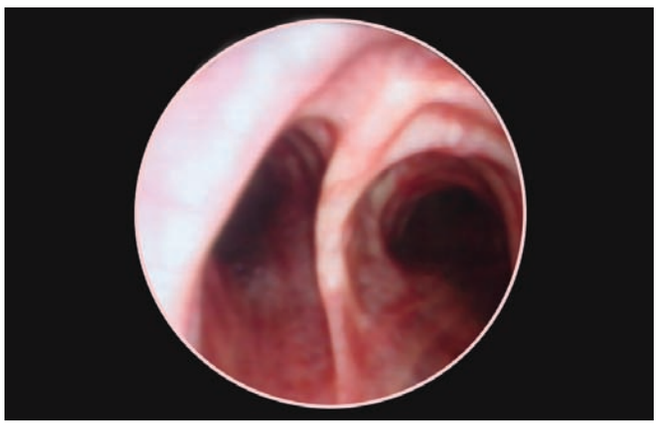

Fig. 17.201: Main carina deviated to left side

Fig. 17.202: Infiltration in the walls of left upper lobe bronchus

CASE 58: SQUAMOUS CELL CARCINOMA IN A 65-YEAR-OLD MALE

This patient, bidi smoker (30/day for 25 years), a known case of COPD for last 5 years, presented with hemoptysis. Chest X-ray showed cavity in the right para hilar area, sputum smear for acid-fast bacilli (AFB) was negative. Keeping hemoptysis as a symptom and cavity in the chest X-ray, he was misdiagnosed as sputum negative pulmonary tuberculosis and was prescribed antitubercular treatment for 6 months, ignoring the characteristic CT picture of malignant cavity (eccentric and irregular inner wall) without any response. CT thorax done after 6 months showed apart from thick wall cavity multiple nodules in the opposite lung, suggestive of secondaries. Fiberoptic bronchoscopy showed multinodular tumor in right main bronchus near main carina. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.203 to 17.208).

CASE 59: SQUAMOUS CELL CARCINOMA IN A 48-YEAR-OLD MALE

This patient, nonsmoker presented with dry cough, breathlessness and chest pain for last 4 months. CT thorax showed left hilar mass with mediastinal lymphadenopathy with left sided pleural effusion. Fiberoptic bronchoscopy showed decreased left vocal

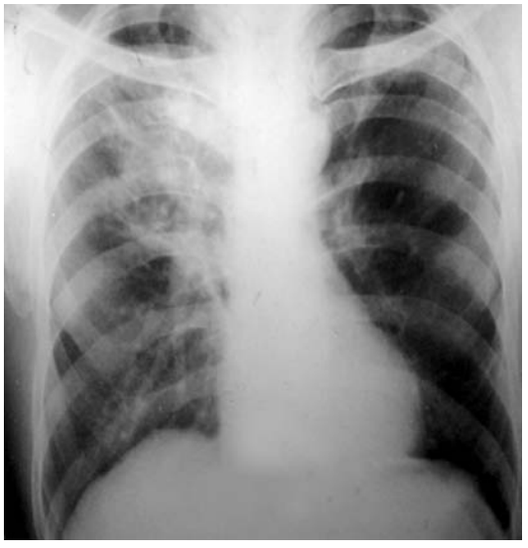

Fig. 17.203: Chest X-ray showing cavity in right parahilar area

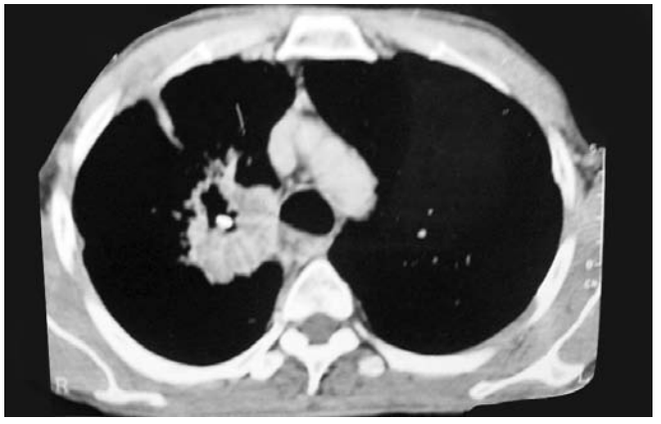

Fig. 17.204: CT thorax showing mass with cavity

Fig. 17.205: Chest X-ray showing cavity in right paratrachial area

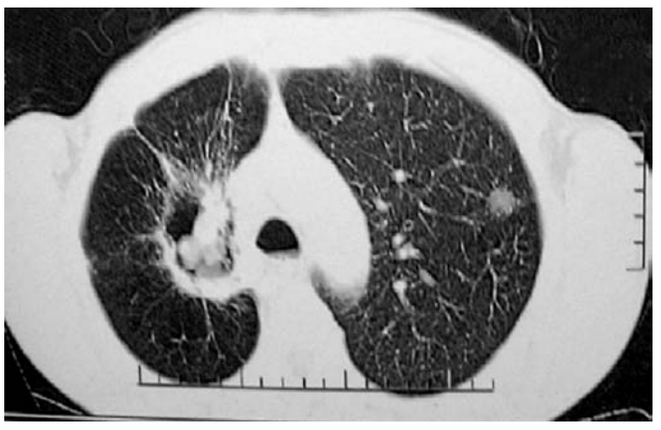

Fig. 17.206: CT thorax showing malignant cavity with multiple nodules in opposite lung

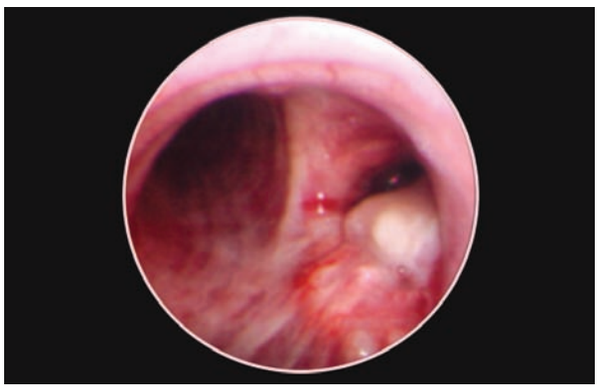

Fig. 17.207: Multinodular tumor in right main bronchus involving main carina

Fig. 17.208: Bleeding after endobronchial biopsy

cord movement. Lower part of trachea bulging medially and main carina deviated to left side. There was a tumor obstructing basal segment of left lower lobe. Histopathology of endobronchial and brush biopsy showed squamous cell carcinoma (Figs 17.209 to 17.212).

CASE 60: SQUAMOUS CELL CARCINOMA IN A 40-YEAR-OLD MALE

This patient, bidi smoker (15/day for 20 years), had recurrent streaking for 1 year and ignored it. 2 months back, he developed cough, with moderate amount of yellow colored sputum with fever. CT thorax showed abscess in right lower lung with obliteration of right main bronchus with enlarged paratracheal lymph node. Multiple nodular lesions, some of them cavitating were seen in both lungs. Small metastatic deposits were also seen in right lobe of liver. Fiberoptic bronchoscopy showed main carina infiltrated with tumor. Secondary carina between right upper lobe bronchus and bronchus intermedius was wide and infiltrated. All the segmental openings of right upper lobe narrowed and bronchoscope could not be passed further. Multiple nodular lesions were seen in left main bronchus. Histopathology of endobronchial and brush biopsy from the right side was consistent with squamous cell carcinoma (Figs 17.213 to 17.220).

Fig. 17.209: Chest X-ray showing mass with pleural effusion in left lung

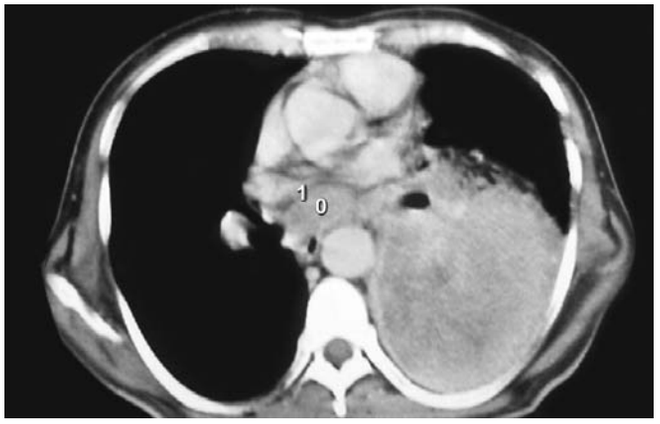

Fig. 17.210: CT thorax showing intrathoracic mass with mediastinal lymphadenopathy

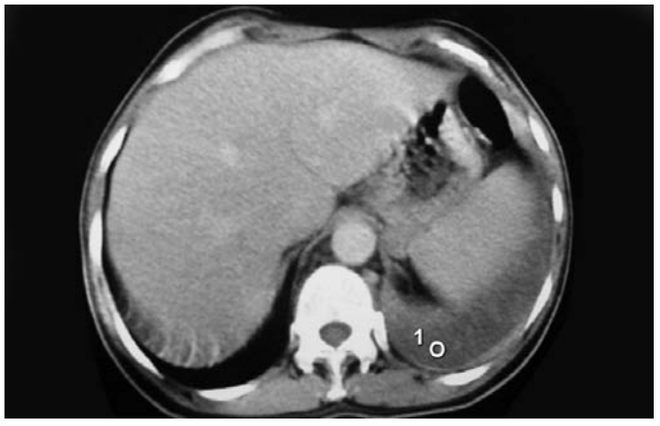

Fig. 17.211: CT thorax showing pleural effusion on left side

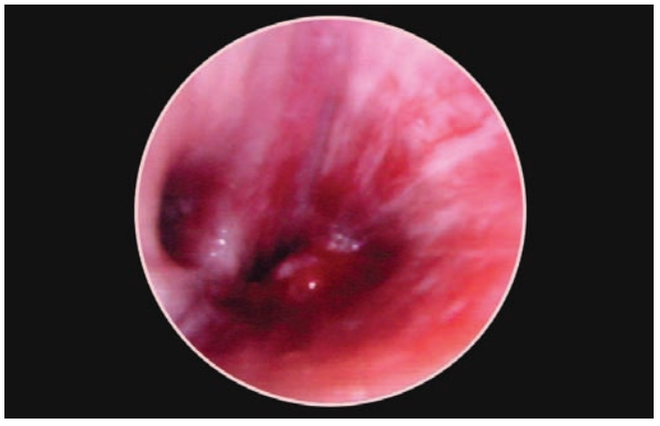

Fig. 17.212: Tumor obstructing basal segment of left lower lobe

Fig. 17.213: Chest X-ray showing radio-opaque shadow in right mid and lower zone with volume reduction

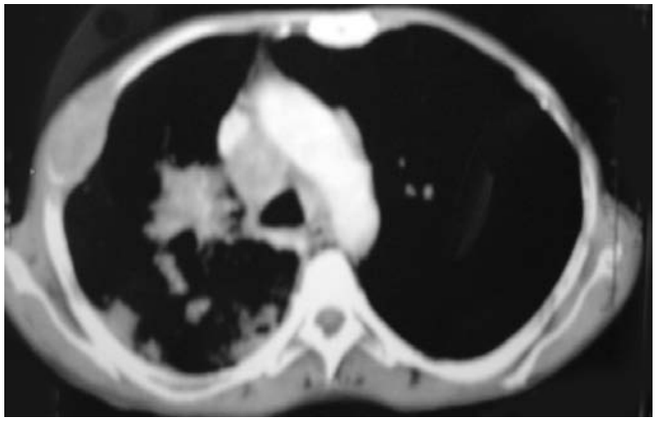

Fig. 17.214: CT thorax showing paratracheal lymph node

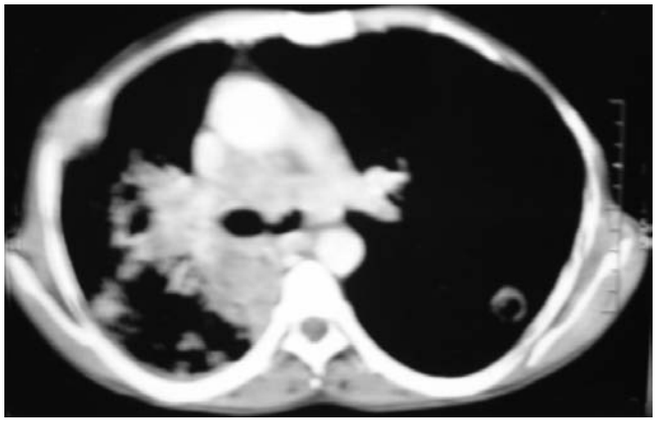

Fig. 17.215: Chest X-ray showing mass with mediastinal lymph node with multiple nodular lesions

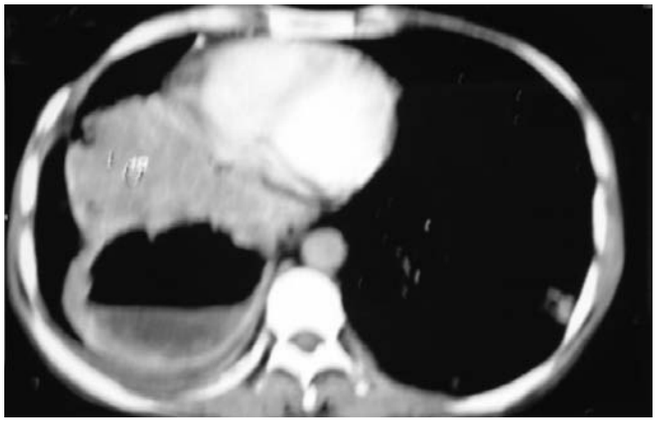

Fig. 17.216: CT thorax showing mass with abscess like picture

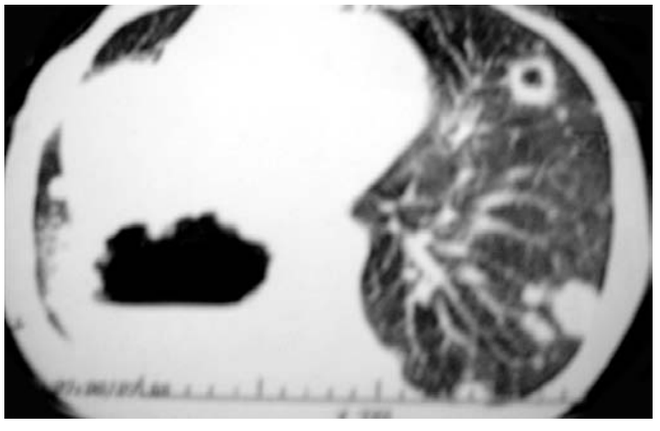

Fig. 17.217: CT thorax showing mass with abscess like picture with multiple nodular lesions, one of them is cavitating on left side

Fig. 17.218: CT thorax showing secondary in liver

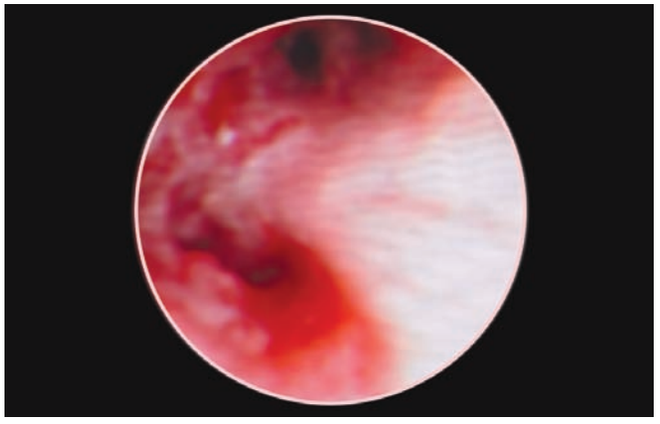

Fig. 17.219: Secondary carina near right upper lobe wide and infiltrated

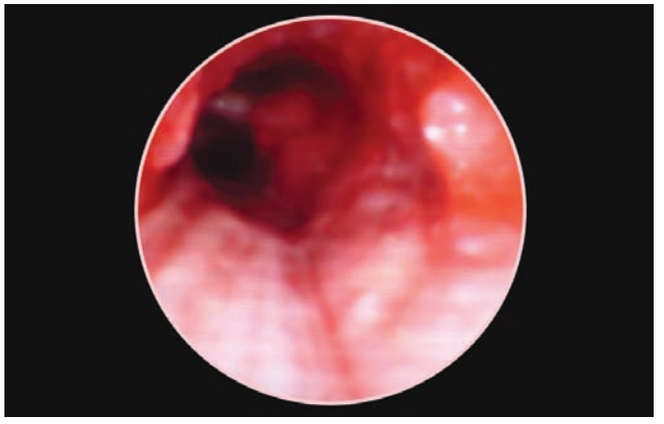

Fig. 17.220: Multiple nodular lesions in left main bronchus

CASE 61: SQUAMOUS CELL CARCINOMA WITH SUPERIOR VENA CAVA SYNDROME IN A 61-YEAR-OLD MALE

This patient, nonsmoker presented with cough, breathlessness, swelling over face and upper limbs for last 3 months. Fiberoptic bronchoscopy showed engorgement of superficial submucosal veins in trachea and left main bronchus. Posterior wall of lower end of trachea was bulging due to compression from out side. There was no endobronchial growth seen. Transthoracic biopsy of the mass showed histopathology suggestive of the squamous cell carcinoma (Figs 17.221 to 17.226).

CASE 62: SQUAMOUS CELL CARCINOMA IN A 65-YEAR-OLD MALE

This patient, bidi smoker (35/day for 45 years), a known case of COPD for last 7 years had presented with lung abscess like presentation with recurrent hemoptysis for last 6 months. Initially, he was misdiagnosed as pyogenic lung abscess and was prescribed antibiotic for 15 days with out any response. He went to another doctor, where he was again misdiagnosed as tuberculosis and was prescribed antitubercular treatment for 5 months with out any response, then he was referred to us. CT thorax showed mass in the right lung extending from the level of carina to level of diaphragm. Small, round, well-defined areas are seen anterior to the mass lesion and one of them was cavitating, suggestive of secondaries. Pleural effusion was also seen on right side. Fiberoptic bronchoscopy showed multiple nodule over main carina. Growth at the lateral wall of the right main bronchus obstructing right main bronchus partially. Growth was also extending to the medial wall of left main bronchus near main carina. Histopathology of endobronchial biopsy was consistent with large cell carcinoma (Figs 17.227 to 17.234).

CASE 63: TRACHEOESOPHAGEAL FISTULA BY SQUAMOUS CELL CARCINOMA ESOPHAGUS IN A 48-YEAR-OLD MALE

This patient, a chronic bidi smoker (30/day for 28 years), presented with recurrent cough, mild hemoptysis and dysphagia for last 1 year. Barium swallow showed that Barium has entered into the bronchial tree through tracheoesophageal fistula. Fiberoptic bronchoscopy showed tracheoesophageal fistula surrounded by lot of granulation tissue. Histopathology of biopsy from margin of fistula was consistent with squamous cell carcinoma. Upper gastrointestinal (UGI) endoscopy also showed growth in esophagus. Biopsy of which was histopathologically consistent with squamous cell carcinoma (Figs 17.235 to 17.238).

Fig. 17.221: Patient with superior vena cava syndrome

Fig. 17.222: Chest X-ray showing right paratracheal mass

Fig. 17.223: CT thorax showing intrathoracic mass

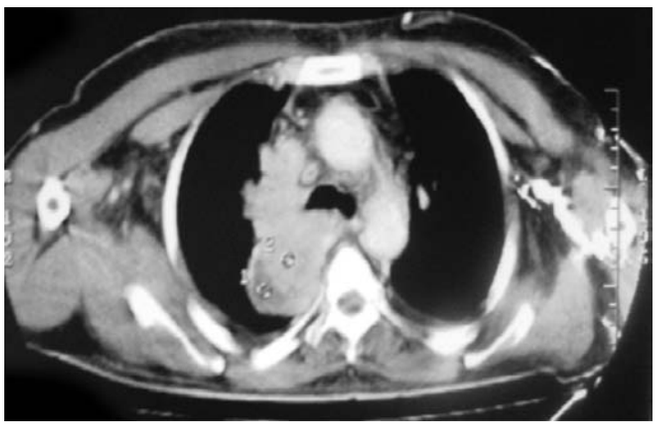

Fig. 17.224: CT thorax showing intrathoracic mass

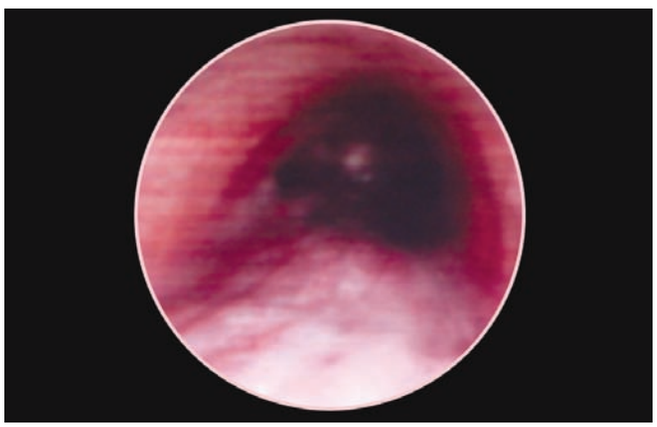

Fig. 17.225: Engorgement of superficial submucosal veins in trachea and bulging of posterior wall of lower end of trachea

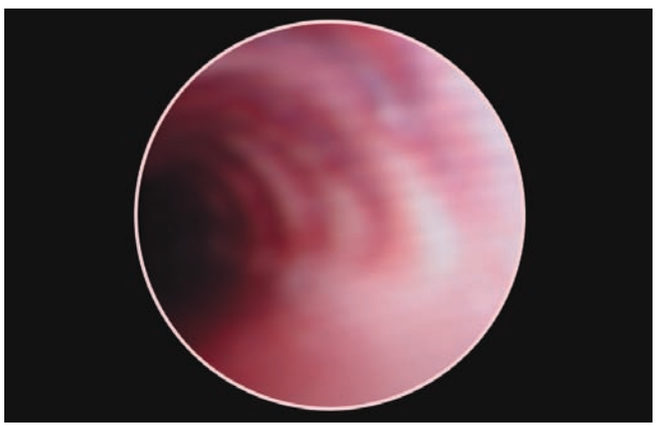

Fig. 17.226: Engorgement of superficial submucosal veins in left main bronchus

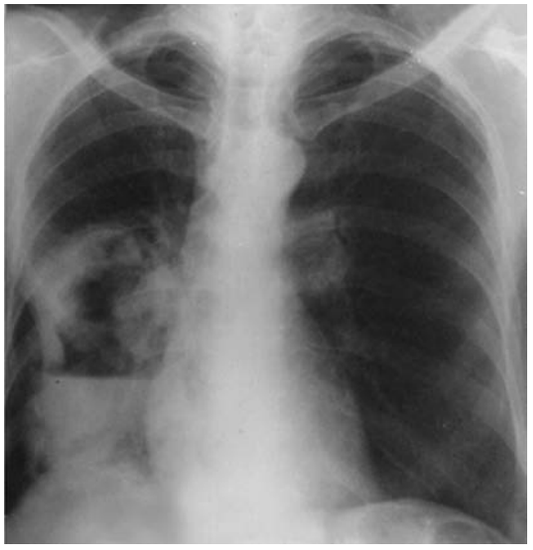

Fig. 17.227: Chest X-ray showing lung abscess like shadow

Fig. 17.228: Chest X-ray showing mass in the middle and lower zone

Fig. 17.229: CT thorax showing intrathoracic mass in right lung

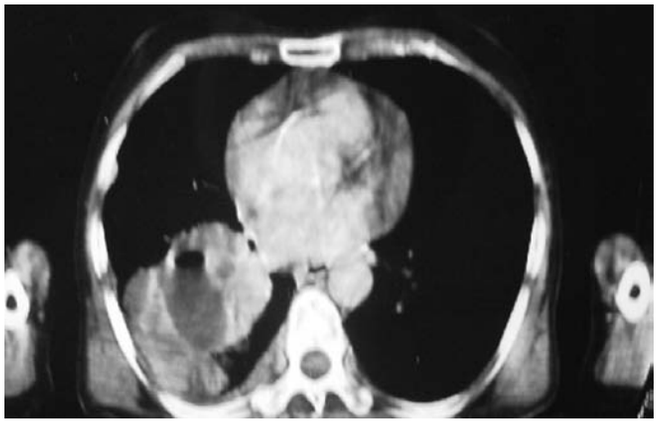

Fig. 17.230: CT thorax showing intrathoracic mass in right lung

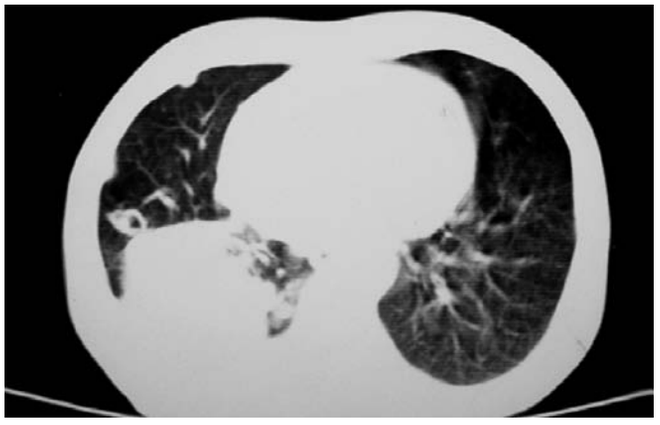

Fig. 17.231: CT thorax showing intrathoracic mass with multiple secondaries

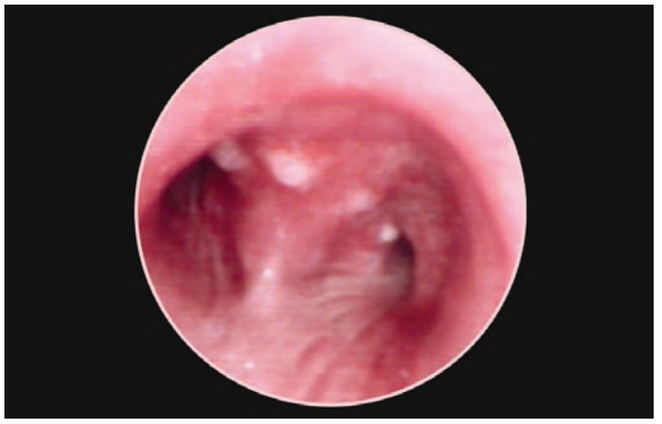

Fig. 17.232: Multiple nodules over main carina

Fig. 17.233: Growth in right main bronchus

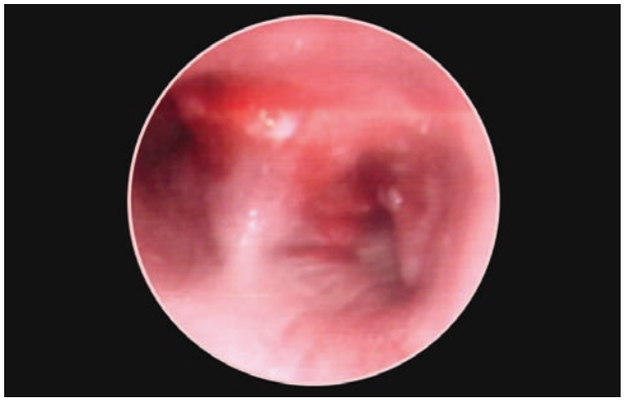

Fig. 17.234: Growth extending into medial wall of left main bronchus

Fig. 17.235: Normal chest X-ray

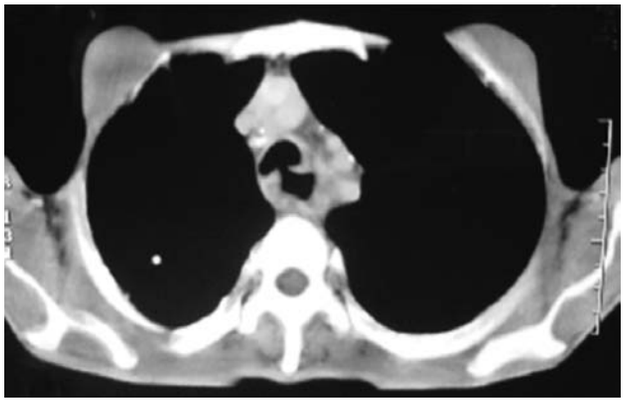

Fig. 17.236: CT thorax showing tracheoesophageal fistula

Fig. 17.237: Barium swallow showing contrast entering left bronchial tree

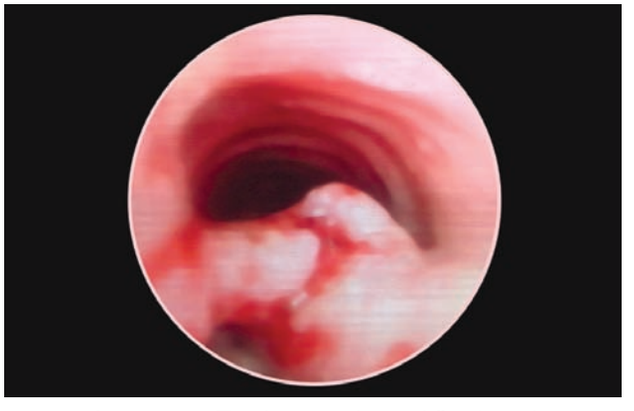

Fig. 17.238: Tracheoesophageal fistula with granulation tissue

CASE 64: UNDIFFERENTIATED CARCINOMA IN A 70-YEAR-OLD FEMALE

This patients, nonsmoker, presented with breathlessness, cough and loss of appetite for last 3 months. Initially, she was diagnosed as tubercular pleural effusion and was given antitubercular treatment with oral steroids for 3 months without any response. Fiberoptic bronchoscopy showed wide main carina with narrowing of middle lobe and lower lobe bronchial openings. Bronchial mucosa surrounding openings are hyperemic and secondary carina were thick. Histopathology of endobronchial biopsy was negative for malignancy. Cytopathology of pleural fluid aspirate was positive for malignant cells. CT thorax showed pleural effusion on the right side with diffuse shadows in the left lung, suggesting lymphangitic carcinomatosis. She was given chemotherapy containing cisplatin and etoposide for sixth cycle and responded well (Figs 17.239 to 17.246).

Fig. 17.239: Chest X-ray showing pleural effusion on right side

Fig. 17.240: Chest X-ray view showing pleural effusion on right side which has incresead

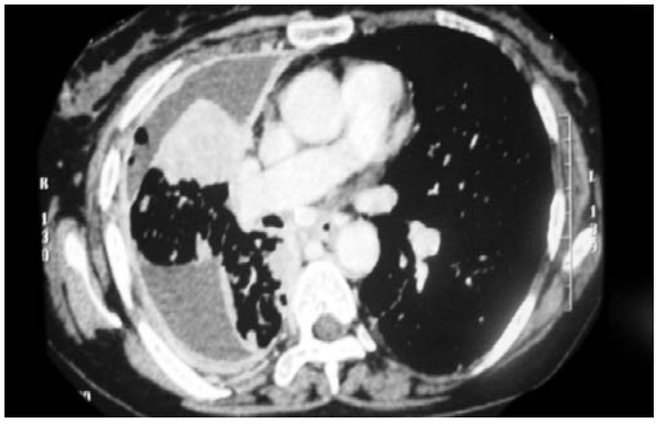

Fig. 17.241: CT thorax showed plural effusion

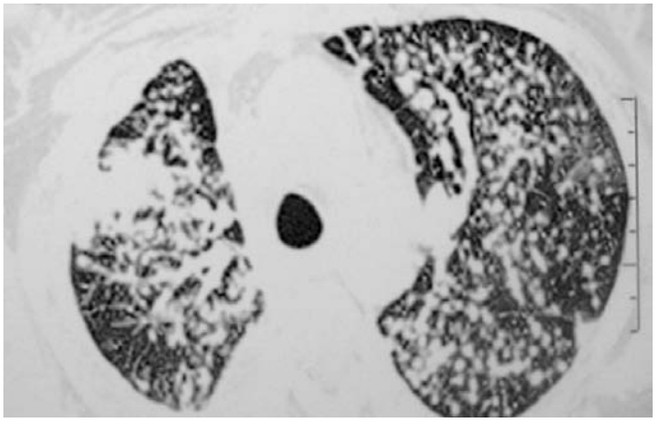

Fig. 17.242: CT thorax showing bilateral diffuse shadows

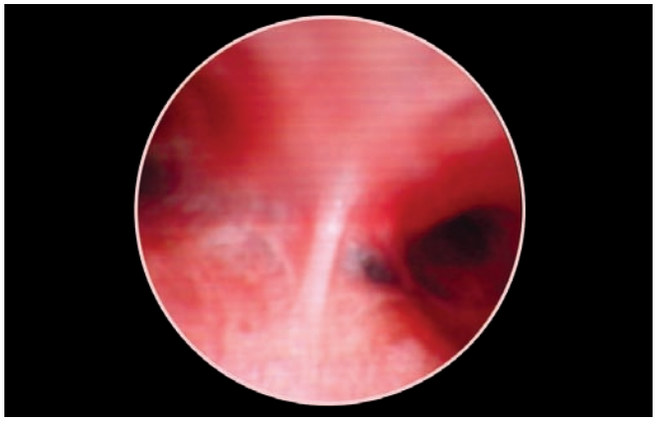

Fig. 17.243: Wide main carina

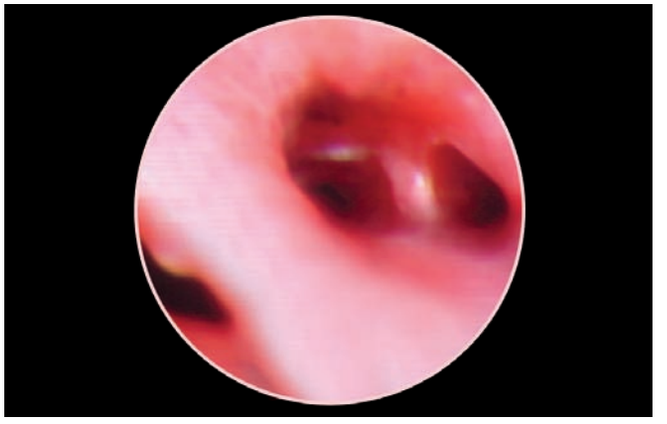

Fig. 17.244: Middle lobe opening narrowed

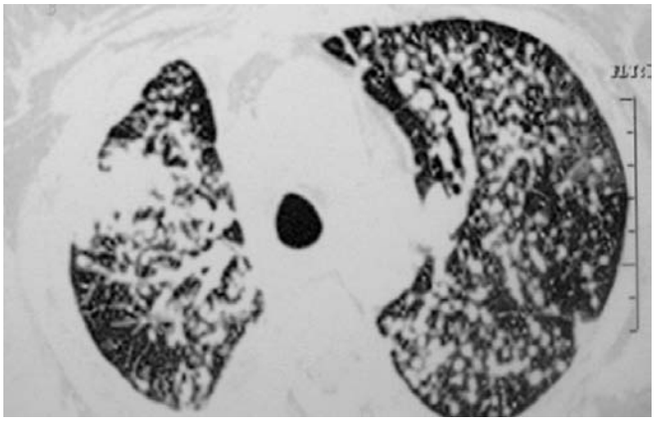

Fig. 17.245: CT thorax showing response after six cycles of chemotherapy

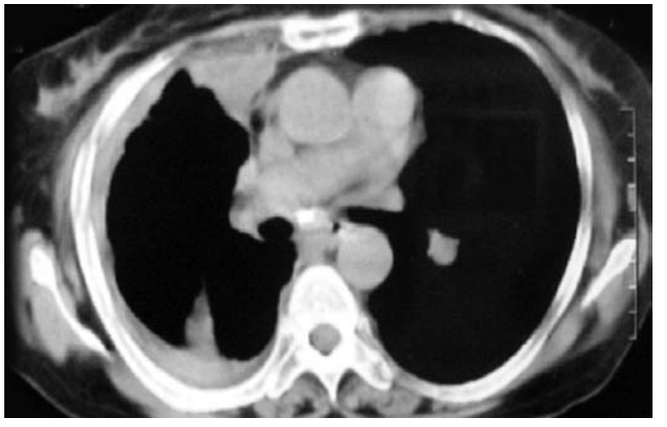

Fig. 17.246: CT thorax showing response after six cycles of chemotherapy

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